Integrated Pest Management for Apple Orchards in Ontario

Ontario

Ministry of Agriculture and Food

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APPLE PEST MANAGEMENT

Pest control on apples requires a combination of all techniques—cultural, biological, and chemical—in a program that is ecologically and economically acceptable to both the producer and the consumer. This approach is called Integrated Pest Management or IPM.

Unlike OMAF Publication 360, *Fruit Production Recommendations*, this publication relies heavily upon pest monitoring and the use of selective pesticides only when pest populations are capable of causing economic injury.

Pesticides recommended in this publication are those which will have the least impact on beneficial organisms in the orchard.

The intent of this publication is to provide information that will enable apple growers to monitor pest activity in their own orchards, and develop sound pest control decisions for the entire pest complex. These guidelines allow for efficient monitoring and confident decision making.

ACKNOWLEDGEMENTS

The information on pest biology, monitoring technology and control strategies has been prepared in consultation with Agriculture Canada Research Scientists at Vineland Station. Agriculture Canada continues to place major emphasis on the maintenance and further development of IPM on apples in Ontario.

INTEGRATED PEST MANAGEMENT FOR APPLE ORCHARDS IN ONTARIO

A handbook for growers, scouts, and consultants

The Ontario Ministry of Agriculture and Food
Plant Industry Branch
Pest Management Section

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TABLE OF CONTENTS

Page

OMAF Advisors for apple growers 4
How to Use This Book 5
Integrated Pest Management 6
The Concept 6
Historical Perspective 6
Thresholds 6
Monitoring Requirements 6
Pesticides Used in This Book 7
Guide for Spraying Fruit Trees 7
Role of Beneficial Insects in Apple Orchards 8
Pest Resistance to Insecticides, Fungicides and Miticides 10
Insecticides 10
Fungicides 11
Miticides 11
Monitoring 11
Procedure for Orchard Monitoring 11
Monitoring Equipment & Techniques 11
Record Keeping 12
Preventing Bee Poisoning 14
Alternate Hosts of Apple Pests 15
Quick Decision Chart (Table 6) 16
Reference Section 34

Disease References 34
1. Apple Scab 34
2. Fire Blight 38
3. Powdery Mildew 38
4. Rust Diseases 39
5. Bordeaux Mixture 39

Page

Insect References 40
6. Apple Maggot 40
7. Codling Moth 40
8. Green Apple Aphid 41
9. Mites 41
10. Mullein Bug 44
11. Plant Bug Complex 45
12. Plum Curculio 46
13. Rosy Apple Aphid 46
14. Scale Insects 46
15. Spring-Feeding Caterpillars 47
16. Tentiform Leafminer 48
17. White Apple Leafhopper 52
18. Woolly Apple Aphid 52

Occasional Pest References 53
19. Phytophthora Collar Rot 53
20. Sooty Blotch and Fly Speck 53
21. Tree Cankers 53
22. Blister Spot 54
23. Apple Seed Chalcid 54
24. Eye-Spotted Bud Moth 54
25. Dogwood Borer and Apple Bark Borer 54
26. Miscellaneous Caterpillars 55
Number of Days from Last Spray to Harvest 55
Chemical Families of Pesticides 56
Selected List of Monitoring Equipment Suppliers 58
Publications 58

LIST OF TABLES

Table	Page
1. Guidelines for Monitoring Pest Activity	5
2. Rate and Water Volumes for Different Tree Sizes	7
3. Common Beneficial Insects Found in Orchards	8
4. Guidelines for Using insect Traps in Orchards	13
5. Some Alternate Hosts of Apple Pests	15
6. Quick Decision Chart	16
7. Relationship of Temperature and Moisture to Apple Scab Infection	34
8. Relationship of Temperature, Hours of Wetting, and Weeks After Full Bloom to Secondary Apple Scab Infection of Fruit	35
9. Retention, Redistribution and After-Infection ("Eradicant") Activity of Some Fungicides for Control of Primary Apple Scab	36
10. Disease Resistance of Apple Cultivars	37
11. Effect of Temperature on European Red Mite Development	43
12. Number of Days From Last Spray to Harvest	55
13. Chemical Families of Pesticides	56
14. Physical Compatibility of Spray Materials	57
15. Selected List of Monitoring Equipment Suppliers	58

LIST OF FIGURES

Figure	Page
1. Diagram of Tapping Tray	12
2. Wing Patterns of Apple Maggot and Related Species	40
3. Distinguishing Injury of Seed Chalcid, Plant Bug and Stink Bug	45
4. Catches of Oblique-banded Leafroller Moths in Sex Pheromone Traps, Niagara Peninsula, 1983	49
5. Life Cycle of TLM	50
6. Leaves to Sample for TLM	51

ONTARIO MINISTRY OF AGRICULTURE AND FOOD ADVISORS FOR APPLE GROWERS

PEST MANAGEMENT ADVISORS

Area Served	Name	Address	Phone No.
Central Ontario	Andrea Clarke	234 King St. E. BOWMANVILLE, L1C 1P5	416-623-3348
Niagara Peninsula	Kevin Ker Gerald Walker	VINELAND STATION, L0R 2E0	416-562-4147
Western Ontario	Pam Fisher	Box 587 SIMCOE, N3Y 4N5	519-426-7120
	Kevin Schooley	50 King St. LONDON, N6A 2P2	519-434-6811
Essex, Kent	Todd Leuty	Research Station HARROW, N0R 1G0	519-738-2251
Georgian Bay	Alison Smith	Box 69 CLARKSBURG, N0H 1J0	519-599-2042
Provincial Plant Pathologist	Craig Hunter	Box 587 SIMCOE, N3Y 4N5	519-426-7120
Eastern Ontario	Bernt Solymar	Smithfield Experimental Farm Box 340 TRENTON, K8V 5R5	613-392-3527

HORTICULTURAL CROP ADVISORS

Eastern Ontario	Deb Hoffman	College of Agricultural Technology, KEMPTVILLE K0G 1J0	613-258-8359
Prince Edward, Hastings, Lennox, Addington, Frontenac	Allan Moynes	Box 470 PICTON, K0K 2T0	613-476-3224
Northumberland, Peterborough	Dave Ridgway	Box 340 TRENTON, K8V 5R5	613-392-3527
Durham, Victoria		234 King St. E. BOWMANVILLE, L1C 1P5	416-623-3348
Simcoe, Dufferin, Grey	Ken Wilson	Box 69 CLARKSBURG, N0H 1J0	519-599-2042
York, Peel	Chris Kessel	35 Van Kirk Dr., #9 BRAMPTON, L7A 1A5	416-451-5474
Halton, Wellington, North Wentworth	Joe Uyenaka	R.R. #1 ANCASTER, L3Y 3K9	416-527-2995
Niagara Peninsula	Burke McNeil	VINELAND STATION, L0R 2E0	416-562-4147
Haldimand-Norfolk, Brant	Steve Rowe	Box 587 SIMCOE, N3Y 4N5	519-426-7120
Oxford, Elgin, Perth, Waterloo	Keith Priest	Box 666 WOODSTOCK, N4S 7Z5	519-537-6621
Lambton, Middlesex, Huron	John Gardner	50 King St. LONDON, N6A 2P2	519-434-6811
Essex, Kent	Leslie Huffman	Research Station HARROW, N0R 1G0	519-738-2251

AGRIPHONE NUMBERS
(for regularly updated recorded messages)

Kingsville	519-733-3151	Ancaster	416-527-9117	Bowmanville	416-623-4944
London	519-438-1014	Vineland	416-562-4345	Smithfield	613-392-3422
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Simcoe	519-426-9664	Georgian Bay	519-599-2915		

HOW TO USE THIS BOOK

This publication is designed to provide you with information on the monitoring and integrated control of insects, mites, and diseases in apple orchards.

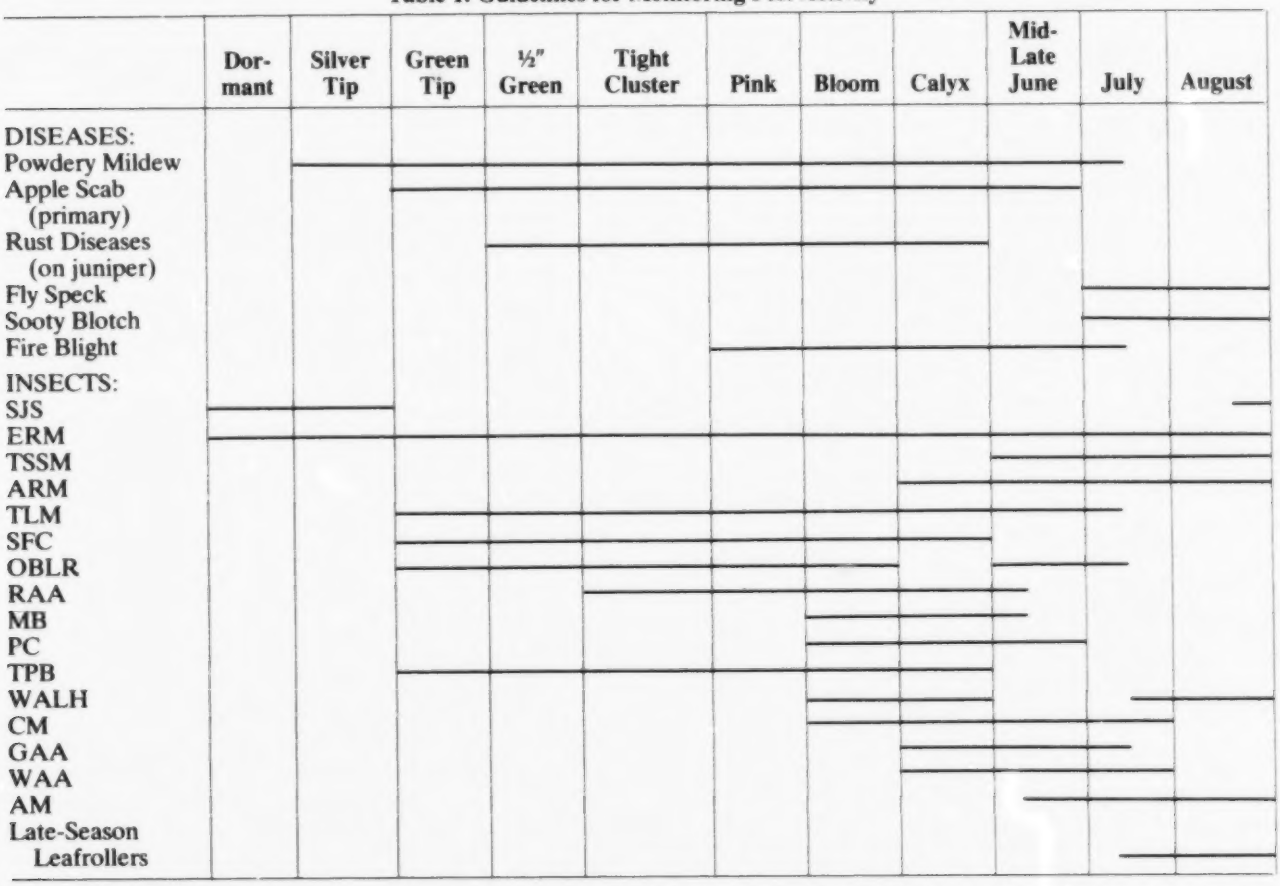
Table 1 provides guidelines on when to monitor for different problems.

The **Quick Decision Chart** (Table 6) is a summary of monitoring techniques, thresholds and integrated controls for each pest.

Important notes on each pest follow the quick decision chart in the **Reference Section**. Read each appropriate reference thoroughly before making pest control decisions.

Minor pests, which seldom cause major crop losses, are not specifically dealt with in the quick decision chart. Brief descriptions of these can be found following the reference section, under Occasional Pests.

Table 1. Guidelines for Monitoring Pest Activity



SJS = San Jose Scale ERM = European Red Mite TSSM = Two-Spotted Spider Mite ARM = Apple Rust Mite TLM = Tentiform Leafminer SFC = Spring-Feeding Caterpillars OBLR = Oblique-banded Leafroller RAA = Rosy Apple Aphid MB = Mullein Bug PC = Plum Curculio TPB = Tarnished Plant Bug WALH = White Apple Leafhopper CM = Codling Moth GAA = Green Apple Aphid WAA = Woolly Apple Aphid AM = Apple Maggot

INTEGRATED PEST MANAGEMENT

The Concept

Pest control on apples requires a combination of all techniques — cultural, biological, and chemical — in a program that is ecologically and economically acceptable both to the producer and consumer. This approach is called Integrated Pest Management, or IPM.

Unlike Ontario Ministry of Agriculture and Food (OMAF) Publication 360, *Fruit Production Recommendations*, this publication relies heavily upon pest monitoring, and the use of pesticides only when pests exceed levels capable of causing economic injury. Pesticides recommended here are those which will have the least impact on beneficial insects in the orchard.

The intent of this publication is to provide information that will enable apple growers to monitor pest activity in their own orchards and develop sound pest control decisions for the entire pest complex. These guidelines allow for efficient monitoring and confident decision making. A grower following this program can expect less than 5% crop injury from all pests combined at harvest.

Historical Perspective

In Ontario, a pilot project for monitoring apple pests began in 1969 in Georgian Bay. By the early 1980's, most apple-growing regions had access to pest monitoring information and were able to benefit from it, primarily by reducing the number of pesticide applications required for effective pest control.

In different apple-growing regions, representative orchard sites are still used for monitoring major pests such as apple maggot and codling moth. The pest complex has changed considerably in the past 15 years, and monitoring now includes more pests. Advice on the timing of sprays for many pests is available to all growers via agriphones. These are telephone answering machines with a 2 to 3 minute message outlining current pest activity and suggested control tactics. The messages are available to growers 24 hours a day, 7 days a week during the growing season (see page 5).

THRESHOLDS

It is neither possible nor desirable to control 100% of all pests in an orchard. The pest threshold is considered to have been reached when the number of pests or amount of injury reaches a level that could result in a crop loss that is greater than the cost of control. The thresholds used in this publication are action thresholds, and refer to the time when a pest must be controlled to prevent this damage.

These thresholds are only guidelines. In most instances, they have not been scientifically determined, but have resulted from many years of field experience. The use of these thresholds will likely limit injury from any single pest to less than 2%.

A grower who is willing to risk increased damage from pests could raise the thresholds and further reduce the use of pesticides in his orchard.

MONITORING REQUIREMENTS

A **regional** monitoring program provides information on pest activity for all growers in an area. Information is gathered from weather recorders, pheromone traps, and observations by OMAF staff. The suggested spray dates are for areas, rather than specific orchards, and apply only to major pests. Minor and sporadic pests are often orchard specific and require **monitoring by the grower** or a scout to determine if, and when, a pesticide application is necessary.

Most pests described in this book require monitoring on a regular basis. On the following pages, a chart outlines monitoring techniques and pest control options for various pests. The guidelines in the Quick Decision Chart (Table 6) are the MINIMUM necessary to follow pest activity. Many pests have a tendency to appear in "hot spots" or pockets of an orchard and may require more frequent observations than indicated in the table.

Apple pests can be placed into two categories: **Direct** and **Indirect**. A **direct** pest causes injury to the fruit. An **indirect** pest injures the tree or leaves, but not the fruit. Injury from an indirect pest may affect tree vigour and influence fruit quality and size. Many pests are both direct and indirect (e.g., scale, leafrollers, aphids).

It is useful to have an up-to-date farm map showing the size of specific blocks, where each variety is located, and the age of the plantings. Building locations, roadways, wild apple trees, and even a description of the surrounding land (e.g., bush, ravines, neighboring farm crops, etc.) can provide useful information to the grower or scout by reminding him where various pests may be located.

Good records of pest activity and pesticide applications are important for evaluating pest control.

PESTICIDES USED IN THIS BOOK

Although there are numerous pesticides registered for controlling pests, there are very few products compatible with IPM. The pesticides listed here are chosen because they are:

1. effective for the target pest, while being less toxic to predators and parasites (these are called selective pesticides);
2. often less toxic to bees and less harmful to the environment;
3. materials which have been used in the past without inducing pest resistance to pesticides.

In some instances, products are listed that are not compatible with an IPM program. These products are recommended for use **only** at specific times in the growing season, and when there are **no other products** available that are ideal for use. Where possible, we urge you to:

1. only use these products **when** there is potential economic loss from the pest **and** no other control tactic is feasible;
2. **alternate** the use of products from different chemical families (see Table 13, page 56) to prevent or delay the development of pest resistance;
3. contact your local Pest Management Advisor or Horticultural Crop Advisor for assistance if specific problems arise that are not covered in this publication.

GUIDE FOR SPRAYING FRUIT TREES

Pesticides must be applied correctly to be effective. A few key points must be stressed:

1. The sprayer must be large enough to cover the orchard in the time available and under adverse weather conditions.
2. Equipment should be in top condition, maintained regularly, and calibrated at least annually.
3. Trees should be pruned to ensure optimum spray coverage.
4. The equipment should have the capacity to supply sufficient volumes of water to ensure thorough coverage for control of the specific pest.
5. The rate of pesticide and the volume of water required will vary depending upon the individual situation. The rates in the spray calendar are based on spraying trees 4.5-5.5 m in height. Trees larger or smaller MAY require more or less pesticide (See Table 2, page 7) As well, the volume of water required to spray the tree will vary in relation to application equipment used, tree size, and the target pest. The original so-called "Dilute" rate was based on spraying a standard tree to runoff. For trees, 4.5-5.5 m in height, this rate is now considered to be 3,000 L/ha. Again, this volume can be adjusted up or down depending upon tree size (See Table 2, page 7). Many growers successfully adjust the rate of pesticide/ha by changing the volume they apply, either by changing the nozzle size or shutting off certain nozzles, or by slightly changing the driving speed. This allows greater flexibility in farms with various-sized trees, while maintaining the same amount of chemical put in each full tank of water.

NOTE Companies are not liable for failure due to use of rates below those recommended on their labels.

6. High-volume sprays (at least 1100 L/ha) are important for control of many pests. Both low-volume applications or low rates of these chemicals have resulted in poor control of scale, mites and woolly aphid, especially in tree tops.

   For oil sprays, enough spray liquid must be used to soak the bark completely. When spraying streptomycin to control fire blight, higher volumes are also required for maximum absorption of the material.

For detailed information on orchard sprayers, see OMAF Publication 373, *Orchard Sprayers*.

Table 2. Rate and Water Volumes for Different Tree Sizes

Tree Height	Pesticide/ha	Water/ha for Dilute Spraying
6 m and over	1⅓ x recommended rate	4000 L
4.5-5.5 m	full recommended rate	3000 L
2.5-3 m	⅔ recommended rate	2000 L

ROLE OF BENEFICIAL INSECTS IN APPLE ORCHARDS

Many orchard pests are attacked by one or more beneficial insects, or beneficial mites, that help reduce pest populations. The presence and abundance of these natural enemies is often affected by horticultural practices and pesticide application. Even in unsprayed orchards natural enemies seldom control all pests completely; however, they can provide adequate suppression of many indirect pests. Integrated pest management programs take advantage of the biological pest control provided by beneficial insects. When chemical controls are necessary in an integrated program, the pesticides which are recommended have a minimal impact on beneficial species while providing adequate control of target pests.

Natural enemies of pests in orchards include both predators and parasites.

Predatory insects are generally as large, or larger, than the pests they feed on. They are quite capable of moving around to search out their food, and they usually consume many pest insects during their lifetime. Ladybird beetles, lacewings, and syrphids are examples of insect predators.

Parasitic insects are smaller than their prey. One or more parasites grow and develop in a single host. The host is slowly destroyed as the parasite larvae feed and mature. Most parasitic insects are wasps or flies. Adult parasites do not usually feed on insects, but are free to move about the orchard, laying eggs in many hosts. Leafminers and leafrollers are often attacked by parasitic insects. An example of a leafminer parasite is the wasp *Pholetesor ornigis*.

Beneficial insects need food to survive in an orchard. Elimination of a food source, or 100% control of a pest, can lead to the elimination of beneficial insects which feed on that pest. Some beneficials don't move into an orchard until pest populations start to increase, others depend on a constant food supply in the orchard. For this reason, beneficial insects are most effective against indirect pests, such as aphids, mites, and leafminer, whose presence in low numbers causes no significant crop loss.

The value of beneficial insects is sometimes not appreciated until they are removed from an orchard system and previously insignificant pests become a problem. The first outbreaks of European red mite followed the use of DDT, which is toxic to many beneficial insects. More recently, increasing populations of woolly apple aphids, mealy bugs, and two-spotted spider mites (TSSM) have been associated with the use of broad-spectrum insecticides in orchards.

Beneficial insects can help prevent or delay the development of pesticide resistance in orchards. Beneficial insects may reduce the number of pesticides required to control a pest, and they will also feed on the resistant pests that survive a pesticide application.

The best biological control success story in apple orchards is the control of ERM and TSSM by a predatory mite, *Amblyseius fallacis*. This predator is resistant to several organophosphorus insecticides and is able to flourish in commercial orchards where only these insecticides are applied. In Ontario during the 1970's, the average number of miticides required in each orchard was one or less per year because of biological control. Unfortunately, *Amblyseius* is very susceptible to pyrethroid and carbamate insecticides used for tentiform leafminer (TLM) control. Carbaryl (Sevin), sometimes used as a fruit thinner, is also very toxic to beneficial mites. The use of these materials has led to a significant decline in predator mite populations in orchards, and has contributed to an increased need for chemical control of mites.

The objectives of this publication are to preserve beneficial insects, whenever possible, without putting the crop at risk. Waiting for pests to reach economic threshold levels before spraying, and applying specific pesticides at times when beneficials are not likely to be present (see Table 3) are two ways to integrate chemical with biological control.

Table 3. Common Beneficial Insects Found in Orchards

Common Name	Brief Description	Favorite Food	Where Found	When Active
PREDATORY MITES				
Amblyseius fallacis	Clear or beige, tear-shaped. Very fast moving (.3mm).	TSSM; also ERM, ARM	Overwinter at tree base. Active in grasses and vegetation April-June. Move into tree canopy after bloom. Found in cracks in bark, under bud scales and on foliage.	Found in tree canopy June-September
Zetzellia mali	Small, (.5mm) bright yellow-orange. Somewhat diamond-shaped.	ARM; also, ERM, TSSM	Found on underside of leaves, mainly along midrib and on bark among ERM eggs.	Spring, summer
Balaustium putmani	Scarlet to dark red with slightly flattened and shiny body (1mm). Larger than ERM. Long legs.	Mites	On bark or on leaves with mites.	Mainly in spring

Table 3. Common Beneficial Insects Found in Orchards (Cont'd)

Common Name	Brief Description	Favorite Food	Where Found	When Active
PREDATORY INSECTS				
Lacewings	Adults have green, long, slender bodies with lacy oval wings (20mm long). Larvae are oblong and tapered, mottled green or grey, with large sickle-shaped jaws (7-8mm long). Eggs—white or grey on long thread-like stalk. Pupae—white round "pill-shaped", often found in calyx or stem end of apples.	Aphids, Mites	Overwinter in cracks in bark and on debris on ground. Eggs laid on leaves and branches. Larvae found on foliage.	Early spring to late summer
Syrphids or Hover Flies	Adults are bee-like flies with habit of hovering. Larvae are legless and slug-like, mottled brown or green (10-20mm).	Aphids	Adults found around flowers. Larvae on bark and on leaves, among aphid colonies.	Early spring to late summer
Cecidomyiids	Adults are small, non-descript flies which are rarely seen. Larvae are small (less than 1mm), legless, and bright orange.	Aphids	In aphid colonies	June-August
Minute Pirate Bugs (Anthocorids)	Adults are small (3-4mm), black bugs with a white diamond mark on back wings. Nymphs are tiny, shiny brown or orange, and very quick.	Mites, Aphids	On leaves	Early spring to late summer
Ladybird Beetles (Coccinellids)	Adults are oval-shaped orange and black beetles with spots (3-4mm). Eggs are yellow and barrel-shaped in clusters. Larvae are elongated with well developed legs and bright markings on dark body (5-6mm).	Aphids, mites, scale insects	Overwinter as adults in debris beneath tree. Adults active on branches and trunk very early in spring. Larvae are found on foliage and branches.	Early spring and summer. Less active in hot weather.
Mullein bugs	Adults are greyish-green oval-shaped bugs (3mm long). Nymphs are very small (1-2mm) green and active with red eyes.	Mites (ERM) aphids. MB nymphs can also be pests of apples.	On leaves, especially fruit clusters or in curled shoots.	Adults are active from late June to October. Several generations/year
Assassin Bugs (Reduviids)	Adults are fairly large, long-legged bugs (20mm). Brownish or black in colour with long curved beak. Abdomen may flare out beneath wings. Nymphs are similar to adults but smaller and without wings.	Aphids, mites, caterpillars and many soft-bodied insects	On bark and foliage of apple trees. Also weeds and other vegetation.	Depending on species, varying locations

Table 3. Common Beneficial Insects Found in Orchards (Cont'd)

Common Name	Brief Description	Favorite Food	Where Found	When Active
PREDATORY INSECTS (cont'd)				
Ground Beetles	Large black or brown shiny beetles, (3-20mm), slightly flat. Larvae are rarely seen.	Omnivorous. Feed on soft-bodied insects on the ground, including codling moth larvae.	Found on the ground beneath soil clumps, vegetative debris or stones, etc.	Nocturnal. Inactive in very dry conditions
PARASITIC INSECTS				
Pholetesor ornigis	Adults are small, black (5mm) wasps with a tiny black spot on each forewing. Pupae are inside white, oval, pill-shaped cocoons.	TLM larvae	Adults active within tree canopy and rest on lower leaf surface. Larvae feed *inside* TLM larvae. Pupae found inside mine of parasitized TLM.	Adults active shortly after each flight of TLM moths
Chalcids	Adults are small (.5-2mm) or very small shiny wasps with pointed abdomens.	TLM larvae and many other caterpillars	Adults active in the canopy. Larvae and pupae found inside mines on leaf.	Early spring to late summer

PEST RESISTANCE TO INSECTICIDES, FUNGICIDES AND MITICIDES

Pests are said to be resistant when they are able to survive exposure to rates of pesticides that previously controlled them. Generally, resistance to a pesticide develops after repeated exposure to a specific chemical. Resistance occurs because a few individuals survive after each spray, while the susceptible portion of the population is killed. These resistant survivors multiply and gradually become the majority of a pest population. Eventually, only a resistant population remains which cannot be controlled by the pesticide. In some cases, there may not be other pesticides available to control the resistant pest.

Two forms of resistance occur: **stable** and **non-stable**. Pests with **stable** resistance are those that will not readily become susceptible to the chemical again once the use of the pesticide is stopped. The resistance of apple scab to dodine (Cyprex/Equal) is considered stable.

In the case of **non-stable** resistance, the resistant pest population will again become susceptible; the period of time in which this will occur depends upon the pest and material in question. For example, ERM populations resistant to cyhexatin (Plictran) would gradually become susceptible if Plictran were not used for 1 to 2 years. (**NOTE** Plictran is no longer available for use.)

The development of pesticide resistance can occur very quickly. The same chemical should not be used repeatedly without being either alternated, or used in combination with chemicals from a different pesticide family. Chemicals in the same pesticide family have the same mode of action. By alternating with a different pesticide family, you are using a chemical that controls the pest in a different way. This practice will reduce the likelihood of resistance developing in the pest population.

You should be aware that there are many chemicals which are the same, or have the same mode of action, and are marketed under different trade names. For example, the chemical dodine is marketed under the brand names **CYPREX** and **EQUAL**. Another important point is that different chemicals may have the same mode of action. For example, both Benlate and Easout have the same mechanism of control. Using Benlate after Easout is equivalent to using Benlate after Benlate; so resistance develops to both chemicals at the same time, even though only one may have been used repeatedly. This is also true for the many pyrethroids.

See Table 13 on page 56 for information concerning chemical families of pesticides.

Insecticides

Pyrethroids The tentiform leafminer has become resistant to all pyrethroids (Ambush, Pounce, Belmark, Decis, Cymbush and Ripcord) in several areas of Ontario. The repeated use of this pesticide family (more than once per season) is not encouraged because it reduces the number of beneficial insects and may lead to the development of resistance in pest populations.

Lannate Several cases of tentiform leafminer resistance to methomyl (Lannate) have been documented in Norfolk County. This product should be used only when necessary

for leafminer or oblique-banded leafroller control, and **never more than once per season**.

Fungicides

If you find that a well-timed application of Benlate, Easout, Cyprex or Equal fails to control apple scab at rates which previously controlled it, you should consider the possibility of fungus resistance to the chemical.

Benlate, Easout Cases of resistant apple scab have been documented in most of the apple-growing areas of Ontario.

Cyprex/Equal Apple Scab has developed resistance to dodine, the active product in both Cyprex and Equal, in a moderate percentage of orchards in most of the apple-growing areas of Ontario. Resistance to dodine is persistent for many years and these products will no longer control apple scab in such an orchard.

Miticides

Kelthane European red mite resistance to dicofol (Kelthane) was widespread in the late 1960's, and a survey in 1984 indicated that it was present in 4% of the apple orchards tested. If Kelthane is not used for 3 to 5 years, the population will gradually lose its resistance. However, if the chemical is used repeatedly (e.g., more than once a year), this resistance will return quite quickly.

MONITORING

The purpose of an orchard inspection is to make an accurate estimate of the insect and disease activity in an orchard block. **Careful observations** can indicate the presence of some pest species in the orchard. The **use of weather equipment, pheromone traps, and tapping trays** can assist in monitoring. **Surveying for symptoms** of damage or injury, such as fire blight strikes or apple scab lesions, is important.

Monitoring helps to determine if pests are numerous enough to require control. It can also help the grower to time pesticide applications to coincide with the most susceptible development stage of the pest. Field observations are also useful in evaluating the effectiveness of control sprays. Perhaps the best incentive for monitoring, however, is the peace of mind that comes with knowing what the pest situation is in your orchard.

Who Should Monitor?

Anyone can monitor if they are willing to spend a considerable amount of time doing so, regularly and consistently, throughout the growing season. Effective monitoring depends on the person's attentiveness and powers of observation. One's ability and confidence in monitoring will improve with proper training, time, and experience. Set aside sufficient time each day or week to monitor various areas of the orchard. In some cases, the grower or a family member may be responsible for this task. In other situations, it may be more convenient for a grower or group of growers to hire an employee whose primary responsibility is scouting for pests.

Procedure for Orchard Monitoring

To get the most out of your scouting time, it is important to prepare before entering the orchard. Review the Pest Activity Chart (Table 1, page 5), the Quick Decision Chart (Table 6, page 16), and the history of pest activity and/or injury in your orchard to determine where to look and what pests may be present. The reference section also provides good tips on monitoring.

When monitoring, it is essential to quantify the extent of the problem rather than to merely determine that the pest is present. For example, knowing specifically that there are 4 tentiform leafminer mines per leaf on Red Delicious and 3 mines per leaf on McIntosh in orchard A, while orchard B has less than 1 mine per leaf on all cultivars is far more valuable information than just knowing that some leafminers exist in both orchards.

Note the pattern, extent, and location of the pest and/or injury. Sometimes only certain orchard blocks or varieties will need treatment. Distinguishing between fresh and old injury will determine whether the grower needs to re-apply a pesticide for further control.

The distribution of pests and/or injury in the tree may indicate pesticide coverage problems. Remember that good spray coverage is easier to obtain on the outside of the tree than on the upper and inside regions. Some pests will be found in these areas, where spray coverage is poorest.

The distribution of pests and/or injury in the orchard (e.g., border vs. interior) may tell something about the pest. For example, damage only to border rows could indicate a migratory rather than a resident pest. Low vigour or dead trees, confined to a low spot or certain area of the field, could indicate poor drainage, root rot, and/or low temperature problems rather than insect injury.

If a pest cannot be identified, a sample of the insect, diseased area, or injury should be brought to the local OMAF office for diagnosis.

How Frequently Should Monitoring Be Done?

It is important to monitor both consistently and frequently because the pest complex changes throughout the growing season. On average, it takes at least one hour each week for a scout to monitor 2 hectares (5 acres). This includes time spent checking leaf samples with a microscope for mites and tentiform leafminer. The time required for monitoring will vary depending on the time of year, size of the orchard, the type, level and number of pests present, and the experience of the person scouting the orchard. When a pest is active and nearing a level that could require control, more frequent monitoring is required. Consult the Quick Decision Chart (Table 6, page 16) and the reference notes on pests to determine the minimum frequency of monitoring required.

Monitoring Equipment and Techniques

The two most important requirements for monitoring are **adequate time** and **good observation**. A 10 to 16X hand lens is also essential.

Monitoring for insects can be aided by traps and a tapping tray. An important aspect of monitoring for diseases is recording the weather, including rainfall, leaf wetness and the average daily temperature.

Insect traps These are simple to use, but must be checked and maintained regularly to be effective for following insect activity.

Insect traps can be chemically or visually attractive to insects.

Visually attractive traps The special shapes and colours of these traps have been designed for recognition by certain pests. In orchards, sticky red spheres and yellow boards are used to trap apple maggot. The placement of these traps is critical; to be effective, they must be seen by the insect. These traps must be kept clean, and all foliage within one foot of each trap should be pruned. (For more information on placement and maintenance of apple maggot traps, see Table 4, page 13.)

Pheromone traps Pheromone traps use synthetic chemicals that mimic the scent used by female insects to attract males. These traps are made up of two components: the pheromone, and the trap. The pheromone, inside a rubber septum or capsule, is placed inside a cardboard trap coated with an adhesive (e.g., Tangle-trap™).

Pheromone traps are usually very specific and will only catch the males of one insect species. Some types of pheromone, however, will also attract other closely related species, so it is important to properly identify the insects which have been trapped. An example of this is clearwing borer pheromone, which may attract not only the *Synanthedon* borer which damages apple trees, but also closely related species that are similar in appearance but do not damage apple trees.

Although pheromone traps, when used properly, will reliably catch a given species of insect, trap counts must be interpreted very carefully. Because only the males of each species are captured, the activity of the females (e.g., population levels, egg laying, etc.) can only be inferred from these trap catches.

Pheromone traps for tentiform leafminer, codling moth, red-banded leafroller, and oblique-banded leafroller are placed in representative orchards in every major apple-growing region of Ontario. In general, the **combined trap counts** from several orchards in an area are more useful than the counts at individual sites. For this reason, most growers will benefit by relying upon the information collected by OMAF and recorded on the agriphone.

Where pheromone traps are used in a monitoring program, they must be checked and cleaned out regularly (e.g., two times a week). After counting the number of pest insects in the trap, use a sharp twig or metal spatula to remove all insects and debris. Replace traps which become excessively soggy or soiled. Most pheromone traps should be placed halfway into the tree canopy. All the foliage within one foot of the trap should be removed often enough to ensure an unobstructed flow of pheromone from the trap. The rubber septum or capsule contains the synthetic female scent which is slowly released over a period of time. During the season, the amount of attractant in the septum declines, making the trap less effective; for this reason, the pheromone capsule may need to be replaced several times. Try not to handle different pheromones at the same time, as they are easily contaminated and will then attract other species.

Tapping trays A tapping tray is a useful tool for monitoring mullein bugs, spring-feeding caterpillars, and other pests at calyx. It is easily made of white, pre-shrunk cotton broadcloth (45 cm x 45 cm) stretched over a wooden frame to form a tight, flat surface. The tray is held beneath a branch which is rapped sharply with a rubber hose or padded stick. (Three raps on a single branch = one "tap.") Insects which fall from the branch are caught on the tray below, where they can be observed and counted. The easiest way to make a tapping tray is to copy one used by a Pest Management Advisor.

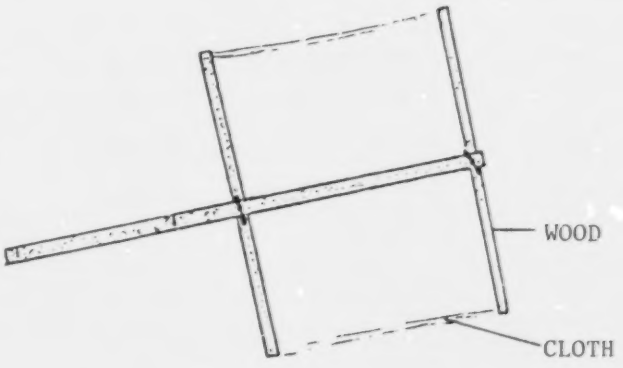


Figure 1. Diagram of a Tapping Tray

Taking samples Leaf samples for insect or mite counts must be handled carefully. Leaves should be placed in a paper bag to absorb moisture and condensation. This should be placed in a plastic bag to keep the leaves and insects from drying out. Keep samples in a cool place. Samples which must be held for several hours or a day should be kept in the refrigerator.

Record Keeping

Record keeping is a good management tool. It is important to arrange records and observations in a clear, concise manner. Good records of both pest activity and pesticides applied are required. These will help identify pest pressures and pesticide sprays, which may differ between blocks and farm locations. Detailed information will help the advisor analyze the situation and diagnose a problem. Accurate records will also establish yearly patterns that form part of the orchard/block history.

Table 4. Guidelines for Using Insect Traps in Orchards

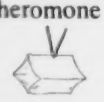
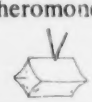
Pest	Tentiform Leafminer	Codling Moth	Oblique-Banded Leafroller	Synanthedon Borer	Apple Maggot
# Traps Per Site	2	4	2	4	5
Type of Trap	Ice-cream carton + pheromone	Pherocon II + pheromone	Pherocon II + pheromone 	Pherocon II + pheromone 	2 red balls + 1 yellow board
Distance Between Traps	30 + m	30-100m	30-100m	30-100m	60-100m
When to Place in Orchards	April 15-20	May 7-15	May 21-25	Mid-June	June 20-30
Placement in Tree	0.5m above ground, against trunk, on sheltered side of tree. Move to lower scaffold limbs after 1st flight	Arm's length into canopy at eye level	Arm's length into canopy at eye level	Close to trunk on lower scaffold limb	On outer canopy, optimally 2m above ground
Arrangement in Orchard	Place in sheltered area of orchard, choose a block of large or standard trees if possible	Upwind from wild or abandoned hosts. At least 2 rows in from edge of orchard. Arrange in a line or box pattern		Place in blocks with borer problems	Place in outer row of trees, facing wild or abandoned apple or hawthorn
When to Change Pheromone	After each generation of moths has emerged (i.e. late May, mid-July)	Once, mid-season (i.e. after 6 weeks)	Mid-season, after counts drop. Trap catches should be graphed	Mid-season	Not applicable. No pheromone. Replace yellow boards in early August
Interpreting Catches	The number of moths caught does not indicate the potential level of infestation. Trapping only indicates when moths are emerging and when to look for eggs	Trap catches from several orchards in an area are pooled and used together with weather data to predict first and peak CM egg hatch	When special sprays are needed; apply 1st 7-10 days after first "shoulder" of adult catches. Watch catches 10-14 days after spray to determine need for second application	Indicates adult emergence. First spray is timed to coincide with peak catch	Trap catches indicate when adults are caught. Continued captures are used to time additional sprays for AM
Factsheet	Spotted Tentiform Leafminer Agdex 211/624	Codling Moth Agdex 211/634	Oblique-Banded Leafroller Agdex 212/624	None	Apple Maggot Agdex 211-634

Table 4. Guidelines for Using Insect Traps in Orchards (Cont'd)

Pest	Tentiform Leafminer	Codling Moth	Oblique-Banded Leafroller	Synanthedon Borer	Apple Maggot
Notes + Cautions	Traps are quickly saturated with moths	Not recommended for grower use		Traps will also catch other species of clear-winged borers not harmful to apple	Traps will catch many kinds of insects. Keep traps clean. Other flies (i.e. Cherry fruit fly, Walnut husk fly) have wing patterns similar to AM. Be sure to identify pest correctly

GENERAL RECOMMENDATIONS

1. Check traps twice weekly.
2. Clear away all foliage within 25 cm of traps. Make sure this area stays clear all season.
3. Always label pheromone traps with the name of the insect.
4. Mark trees having traps with ribbon for easy finding. Although the ribbon will be easy to see early in the season, remember that as the tree canopy fills in visibility will become difficult. Large strips of ribbon should be put either around the trunk below the scaffold limbs, or attached to the outermost large branches.
5. Remember: Pheromone traps may indicate insect activity but they do not indicate the need to spray. The **numbers** of insects caught do not correlate to the potential for damage.

PREVENTING BEE POISONING

Bees are essential for the pollination of most tree and small fruits. Insecticides, many of which kill bees, are required for insect control. With careful management, you can obtain both pollination and insect control. You can protect the bees by following these suggestions:

1. **Do not apply insecticides while tree fruits are in bloom. The Bees Act makes it an offense to do so in Ontario.**
2. Remove honeybee colonies as soon as pollination is complete and before any post-bloom insecticides are applied.
3. Time of treatment is important. In general, daytime treatments, when bees are foraging in the field, are most hazardous. Insecticide applications in the very early morning or evening are safest.
4. If there is a risk of honeybee poisoning, try to choose an insecticide that is not highly toxic to the bees (see below).
5. Honeybees frequently are poisoned by visiting cover crops, such as dandelions or clovers, that are in bloom in the orchard. Clipping or beating down such crops prior to spraying will help safeguard against bee poisoning.

The following groups of chemicals show the relative toxicity of pesticides to honeybees as determined by laboratory and field tests in California. Only those pesticides included in this publication are listed here.

GROUP I. Pesticides Extremely Toxic to Bees

This insecticide has caused more loss (confirmed cases of poisoning) of bees than any of the other materials listed below. Fruit growers and apiarists require close liaison where this material is applied:

Sevin

GROUP II. Pesticides Highly Toxic to Bees

Severe losses may be expected if the following materials are used when bees are present at treatment time or within a few days thereafter:

Ambush	Cymbush	Imidan
APM	Decis	Pounce
Belmark	Diazinon	Ripcord
Cygon	Guthion	

GROUP III. Pesticides Moderately Toxic to Bees

These can be used around bees if dosage, timing, and method of application are correct, but should not be applied directly on bees in the field or at the colonies:

Carzol	Lannate	Thiodan
Dikar	Pirimor	

GROUP IV. Pesticides Relatively Non-Toxic to Bees

Benlate	Easout	Morestan
Bordeaux	Equal	Omite
captan	Karathane	Phaltan
Cyprex	Kelthane	Phygon
Dithane	Manzate	Polyram
		zineb

ALTERNATE HOSTS OF APPLE PESTS

Many apple pests have alternate hosts which are sources of problems for orchards. Wild and abandoned fruit trees (i.e. apple, cherry, pear, plum), hawthorn, and crab apple harbour some of the most serious orchard pests.

Alternate hosts within at least 800 feet of the orchard should be removed. An awareness of where pests may be coming from is useful when monitoring for different pests and for detecting problems early.

Table 5. Some Alternate Hosts of Apple Pests

Insect	Alternate Host(s)
Tentiform Leafminer	apple, hawthorn, wild cherry, quince, plum, crab apple
San Jose Scale	peach, pear, plum, currants; more than 700 host plants recorded
Oystershell Scale	pear, deciduous trees and bush fruits, hawthorn, cotoneaster
European Fruit Scale	peach, plum, apricot, pear, cherry, nectarine, currants, birch
European Red Mite	deciduous fruit, elm, other deciduous forest trees
Two-Spotted Spider Mite	150+ economic crops, weeds, ornamental plants
Green Apple Aphid	pear, quince, hawthorn, mountain ash, crab apple
Rosy Apple Aphid	narrow leaf plantain
Woolly Apple Aphid	pear, quince, ornamental apple, cotoneaster, pyracantha, hawthorn, mountain ash, elm
Tarnished Plant Bug	most green plants
Mullein Bug	mullein, potato, pear and other Rosaceae
Plum Curculio	plum, pear, quince, hawthorn, crab apple, cherry, apricot, peach
Codling Moth	walnut, quince, crab apple, hawthorn, stone fruits
Apple Maggot	hawthorn, wild apple, plums, pear, cherry
Oblique-Banded Leafroller	roses, stone fruits, raspberry, blackberry, many other Rosaceous hosts
Red-Banded Leafroller	cherry, peach, plum, grape, several small fruits, vegetable crops, ornamentals, weeds
Dogwood Borer	dogwood, flowering cherry, mountain ash, hickory, pecan, oak, willow, birch, bayberry, etc.
Potato Leafhopper	200+ host plants
Green Fruit Worm	fruits, shrubs, shade and forest trees
Spring-Feeding Caterpillars	hardwood trees
Eye-Spotted Bud Moth	blackberry, pear, plum, cherry, quince, raspberry, hawthorn
White Apple Leafhopper	cherry
Apple Scab	crab apple, apple
Fire Blight	pear, mountain ash, pyracantha, 125+ species of Rosaceae
Powdery Mildew	apple, pear, quince
Cedar-Apple Rust	Eastern red cedar (*Juniperus virginianae*), apple, flowering crab apple
Quince Rust	some junipers, including Eastern red cedar
Cankers	hardwoods, also apple, quince, hawthorn, serviceberry

TABLE 6A. QUICK DECISION CHART

Read the Label and Follow all Safety Precautions

Phenology	Pest	Most Susceptible Cultivars	Monitoring Procedure & Frequency of Observation	Action Threshold
Dormant	Scale Insects	Large trees with dense growth and rough bark	Check prunings for scale insects and encrustations. Peel wood and look for staining. Refer to previous season's harvest records for fruit injury.	Fruit injury in previous harvest
Green Tip to Half-inch Green	Apple Scab primary infections	All commercial cultivars, especially McIntosh	Monitor weather conditions (wetting periods, temperature). Consult local agriphone for ascospore development.	Green tissue must be protected at all times.
	Powdery Mildew	Idared, Cortland, Rome, Northern Spy, Paulared	Protectant sprays must be applied early, before symptoms appear. See Reference 3.	Susceptible cultivars must be protected until terminal buds set.

For trees more than 5.5 m or less than 4.5 m high, adjust rates as indicated on page 7, Guide for Spraying Fruit Trees.

Time of Application	Effective Materials	Amount Per Hectare	Warnings	Other Pests Affected	Reference Number
While trees are fully dormant (late March to early April)	Superior (60-70 viscosity) oil	60 L (up to 90 L for large trees)	Do not use oil within 48 hours of freezing temperatures. Oil may injure certain cultivars. MAKE NO MORE THAN ONE APPLICATION OF SUPERIOR OIL PER YEAR.	ERM, GAA, RAA	14
Prior to infection period	(1) **metiram** Polyram 80 DF (2) **captan** Captan 50 WP Captan 80 WP (3) **dichlone** Phygon XL 50 WP (4) **mancozeb** Manzate 200 80 WP Dithane DG	 6.00 kg 6.00 kg 3.75 kg 850 g 6.00 kg 6.00 kg	Alternation of fungicides is advisable. Do not apply dichlone for 5 days after frost injury, or if there is a chance of frost. Mancozeb may cause fruit injury to Golden Delicious.	Rust	01
Every 7-10 days	(1) **dinocap** Karathane 18.25 WD (2) Dikar WP (3) **benomyl mixes** Benlate 50 WP (a) **metiram** Polyram 80 DF (b) **captan** Captan 50 WP (c) **mancozeb** Manzate 200 80 WP (4) **thiophanate-methyl** Easout 70 WP (a) **captan** Captan 50 WP	 3.5 kg 7.5 kg 1.1 kg, plus one of: 3.25 kg 3.25 kg 3.25 kg 625 g, plus 3.25 kg	Dinocap must be used with one of the apple scab protectant fungicides found above for apple scab control. Dinocap and benomyl are harmful to beneficial mites. **For control of apple scab with the mixtures 3 and 4, the higher rates found under apple scab for Polyram 80 DF, Captan 50 WP, and Manzate 200 80 WP must be used.**	ERM Scab Scab Scab	03

TABLE 6B. QUICK DECISION CHART

Read the Label and Follow all Safety Precautions

Phenology	Pest	Most Susceptible Cultivars	Monitoring Procedure & Frequency of Observation	Action Threshold
Half-inch Green to Tight Cluster	European Red Mite	Delicious & related cultivars	Check fruit spurs for overwintering mite eggs.	No threshold at this timing
Tight Cluster to Full Pink	Tentiform Leafminer	All cultivars	Collect a minimum of 5 fruit spurs from each of 5 widely separated trees (total 25 spurs per block). Sample at least once per week through petal fall. Check especially Idared, McIntosh and Delicious.	3 or more eggs per spur
	Spring-feeding Caterpillars	All cultivars	Check 10 terminals from each of 10 trees (100 total). Check on a weekly basis. Sample from rows adjacent to woodlots or bush areas.	12-15 damaged terminals
	Tarnished Plant Bug, other plant bugs	All cultivars	Check for overwintering adult activity and check buds and fruitlets for ooze.	Blocks with a history of excessive damage.

For trees more than 5.5 m or less than 4.5 m high, adjust rates as indicated on page 7, Guide for Spraying Fruit Trees.

Time of Application	Effective Materials	Amount Per Hectare	Warnings	Other Pests Affected	Reference Number
No later than tight cluster. Best before egg hatch	Superior (60-70 viscosity) Oil	60 L (up to 90 L for large trees)	Oil should be considered the first line of defence against mites. Do not use oil within 48 hours of freezing temperatures. Oil may injure certain cultivars. MAKE NO MORE THAN ONE APPLICATION OF SUPERIOR OIL PER YEAR.	RAA	09
At first egg hatch. Consult agriphone	(1) **permethrin** Ambush 500 EC Pounce 384 EC (2) **fenvalarate** Belmark 300 EC (3) **deltamethrin** Decis 2.5 EC (4) **cypermethrin** Ripcord 400 EC Cymbush 12.5 WP	 400 ml 520 ml 450 ml 500 ml 250 ml 800 g	All materials listed are pyrethroids and are harsh on beneficial insects and mites. NEVER APPLY MORE THAN ONCE PER SEASON. If one of these materials is to be used, do not apply within 48 hours of first bloom, or when bees are in the orchard.	SFC, TPB	16
When threshold is reached.	(1) **azinphos-methyl** Guthion 50 WP APM 50 W	 2.1 kg 2.1 kg	This spray is not needed if a pyrethroid was applied for TLM.	TPB	15
Before bloom. (Alternate timing is immediately at petal fall.)	(1) **azinphos-methyl** Guthion 50 WP APM 50 W (2) **dimethoate** Cygon 480 E	 2.1 kg 2.1 kg 2.5 L	Preferred timing is pre-bloom. Dimethoate provides poor to fair control of SFC. Dimethoate may cause fruit russetting.	MB, SFC, WALH, Aphids	11

TABLE 6C. QUICK DECISION CHART

Read the Label and Follow all Safety Precautions

Phenology	Pest	Most Susceptible Cultivars	Monitoring Procedure & Frequency of Observation	Action Threshold
Tight Cluster to Full Pink (continued)	Rosy Apple Aphid	Idared, Cortland, Delicious, Rhode Island Greening	Examine interior fruit clusters, 10 per tree for each of 10 trees in a standard orchard or 5 per tree for each of 20 trees in a dwarf planting (100 total). Check weekly from tight cluster until late June.	10 or more clusters infested
	European Red Mite	All cultivars, especially Delicious	Examine fruit spurs and twigs for overwintering ERM eggs and percent hatch. Check at least once weekly or more frequently in warm weather.	5-7 active mites per leaf
	Apple scab	Use one of the scab protectant fungicides listed in Green Tip.		
	Cedar-Apple Rust	Mutsu, Idared, Golden Delicious	Watch Eastern red cedars (junipers) for developing orange spore-producing horns on overwintering galls, especially after prolonged periods of rainfall.	Protectant sprays must be applied before symptoms appear on apple. See Reference 4.
	Quince Rust	Delicious, Golden Delicious, Mutsu		

For trees more than 5.5 m or less than 4.5 m high, adjust rates as indicated on page 7, Guide for Spraying Fruit Trees.

Time of Application	Effective Materials	Amount Per Hectare	Warnings	Other Pests Affected	Reference Number
When threshold is reached	(1) **pirimicarb** Pirimor 50 WP	1.7 kg	See reference	WALH, WAA	13
More than 50% egg hatch	(1) **chinomethionat** Morestan 25 WP	2.25 kg	MITICIDES ARE MOST EFFECTIVE WHEN USED ALONE. Do not use Morestan within 14 days of oil application. Only use prior to bloom. Carzol is harsh on beneficial mites, beneficial insects and bees.	TSSM, Powdery Mildew	09
	(2) **formetanate-hydrochloride** Carzol 92 SP	1.1 kg		TSSM, WALH	
			Alternation of fungicides is advisable.		01
Prior to infection period	(1) **ferbam** Ferbam 76 WDG	2.5 kg	A rust control program with materials 2, 3 or 4 should control apple scab.	Scab	04
	(2) **Dikar WP**	6.00 kg			
	(3) **metiram** Polyram 80 DF	6.00 kg			
	(4) **mancozeb** Dithane DG	6.00 kg			

TABLE 6D. QUICK DECISION CHART

Read the Label and Follow all Safety Precautions

Phenology	Pest	Most Susceptible Cultivars	Monitoring Procedure & Frequency of Observation	Action Threshold
Tight Cluster to Full Pink (continued)	Fire Blight	Idared, Lodi, Paulared	Monitor weather for temperature and rainfall	Infection likely if temperature greater than 18°C, humidity greater than 60%, rainfall or heavy dew has occurred.
Bloom	DO NOT APPLY INSECTICIDES WHILE TREES ARE IN BLOOM.			
	Apple Scab Powdery Mildew Rust Fire Blight	Maintain disease control program during bloom period as in Green Tip to Half-inch Green, Tight Cluster to Full Pink.		
Calyx-when most petals have fallen	REMOVE BEES BEFORE APPLYING CALYX SPRAY.			
	Tentiform Leafminer	All cultivars	Collect at least 5 leaves from each of 10 trees (total of 50 leaves or more). Leaves should be selected from fruit or leaf clusters. Sample at least once a week.	1 or more sap feeders per leaf
	Mullein Bug	Delicious, Northern Spy, Golden Delicious, and early cultivars	Using a tapping tray, sample one limb from each of 25 trees throughout the block. Sample twice weekly from bloom for 4 weeks.	More than 3-5 nymphs per 25 taps
	European Red Mite Two-Spotted Spider Mite	All cultivars, especially Red Delicious	Collect at least 2 leaves from each of 25 widely separated trees (50 leaves in total). Leaves should be selected at arm's length into the tree canopy. Sample at least once per week.	2-3 active mites per leaf, PLUS EGGS

For trees more than 5.5 m or less than 4.5 m high, adjust rates as indicated on page 7, Guide for Spraying Fruit Trees.

Time of Application	Effective Materials	Amount Per Hectare	Warnings	Other Pests Affected	Reference Number
Full pink through bloom. Immediately before rainfall.	(1) **Streptomycin sulfate** Streptomycin 17	600 g/1000 L	High-volume spraying under slow drying conditions is essential. Best applied alone.		02
			Refer to notes on Bee Poisoning.		
			Do not use dichlone during bloom. Alternation of fungicides is advisable.		
Delay application until first tissue feeders appear	(1) **methomyl** Lannate L	6.75 L	This material is toxic to beneficial insects and predatory mites. Do not apply to Early McIntosh, Wealthy and Summer Glo cultivars. Thorough spray coverage is essential. DO NOT USE MORE THAN ONCE PER SEASON.	MB, WALH, SFC, OBLR, Aphids	16
At threshold	(1) **diazinon** Diazinon 50 WP	3.25 kg	Timing is critical. This material is harsh on beneficial mites and insects. Only spray susceptible cultivars.	PC, SFC, Aphids	10
Apply no later than 14 days after petal fall. Apply when mites are mainly in the egg stage, and before there are more than 3 active mites per leaf.	(1) **Clofentezine** Apollo SC	300 mL	**THOROUGH COVERAGE IS ESSENTIAL FOR GOOD CONTROL.** Apply Apollo alone, in no less than 1100 L of water/ha. Make no more than one application of Apollo per year. Apollo does not kill adult mites.		9

TABLE 6E. QUICK DECISION CHART

Read the Label and Follow all Safety Precautions

Phenology	Pest	Most Susceptible Cultivars	Monitoring Procedure & Frequency of Observation	Action Threshold
Calyx—when most petals have fallen (continued)	Plum Curculio	All cultivars	Check fruit for injury. Injury often found on trees adjacent to woodlots and bush areas. First injury usually on wild hosts. Check twice weekly until early July. First pest activity often occurs after warm, rainy weather.	Not determined
	White Apple Leafhopper	All cultivars	Examine 10 leaves from each of 10 trees (100 leaves total) from the inner canopy. Examine weekly, beginning at bloom and continuing 7-10 days after calyx.	2-5 nymphs/leaf
	Apple Scab primary and secondary	All commercial cultivars	Monitor weather conditions (wetting periods, temperature). Consult local agriphone for ascospore development.	Green tissue and fruitlets must be protected at all times.

For trees more than 5.5 m or less than 4.5 m high, adjust rates as indicated on page 7, Guide for Spraying Fruit Trees.

Time of Application	Effective Materials	Amount Per Hectare	Warnings	Other Pests Affected	Reference Number
First injury in orchard. Consult agriphone.	(1) **azinphos-methyl** Guthion 50 WP APM 50 W	 2.1 kg 2.1 kg	Border sprays may be adequate for PC only. A repeat application may be necessary if new injury is observed.	SFC, MB, TPB	12
At threshold	(1) **pirimicarb** Pirimor 50 WP	 1.7 kg	Sprays most effective against young nymphs.	GAA, RAA, WAA	17
Maintain fungicide coverage until primary apple scab season is over. Consult agriphone for ascospore development.	Use a material listed under Green Tip, except dichlone.		Secondary scab infection periods are longer than for primary infection. See reference. Alternation of fungicides is advisable.		01

TABLE 6F. QUICK DECISION CHART
Read the Label and Follow all Safety Precautions

Phenology	Pest	Most Susceptible Cultivars	Monitoring Procedure & Frequency of Observation	Action Threshold
Calyx—when most petals have fallen (continued)	Powdery Mildew	Idared, Cortland, Rome, Northern Spy, Paulared	Watch for white powdery fungus on leaves and shoots	Susceptible cultivars must be protected until terminal buds set.
	Fire Blight	Idared, Lodi, Paulared	Monitor weather for temperature and rainfall. Check for spur blight and blossom blight.	Maintain protective program if following conditions are met: temperatures more than 18°C, history of fire blight in orchard, vigorous growth.
	Cedar-Apple Rust Quince Rust	Mutsu, Golden Delicious, Idared Delicious, Golden Delicious, Mutsu	Watch Eastern red cedars (junipers) for developing orange spore-producing horns on overwintering galls, especially after prolonged periods of rainfall.	Protectant sprays must be applied before symptoms appear. See Reference 4.
First Summer Spray	Codling Moth	All cultivars	OMAF operates a regional monitoring program for CM activity. Information is available from your local agriphone.	Not determined
	Green Apple Aphid	All cultivars	Examine 3 terminals per tree for each of 10 trees (30 terminals total) on a weekly basis from petal fall until terminal buds are set.	More than 20% of terminals (6 out of 30) are infested or fruit blemish is imminent.

For trees more than 5.5 m or less than 4.5 m high, adjust rates as indicated on page 7, Guide for Spraying Fruit Trees.

Time of Application	Effective Materials	Amount Per Hectare	Warnings	Other Pests Affected	Reference Number
Every 7-10 days until terminal bud set.	Use a material listed under Green Tip		See Green Tip	Scab	03
Before rainfall with threshold	(1) **streptomycin sulfate** Streptomycin 17	 600 g/1000 L	Where strikes are observed, cultural controls may help. See Reference 2. Apply streptomycin sulfate immediately following hail injury.		02
Until 10 days after calyx	Use a material listed under Tight Cluster to Full Pink.			Scab	04
Peak egg hatch. Call agriphone.	(1) **azinphos-methyl** Guthion 50 WP APM 50 W	 2.1 kg 2.1 kg	Additional sprays in the summer for control are likely necessary in most areas. Spray timing varies. Consult agriphone regularly. See Reference 7.	PC, OBLR	07
At threshold	(1) **pirimicarb** Pirimor 50 WP	 1.7 kg	Specific sprays for aphid control are seldom necessary. Beneficial insects usually control aphids in orchards on an IPM program. If necessary, a dilute application before leaves curl is most effective.		08

TABLE 6G. QUICK DECISION CHART

Read the Label and Follow all Safety Precautions

Phenology	Pest	Most Susceptible Cultivars	Monitoring Procedure & Frequency of Observation	Action Threshold
First Summer Spray (continued)	Apple Scab	All cultivars except "Scab resistant" varieties.	Check orchard thoroughly for the presence of apple scab lesions on fruit and leaves.	Presence of lesions
				Absence of lesions
	Powdery Mildew	Idared, Cortland, Rome, Northern Spy, Paulared	Watch for white powdery fungus on leaves and shoots.	Susceptible cultivars must be protected until terminal buds set

For trees more than 5.5 m or less than 4.5 m high, adjust rates as indicated on page 7, Guide for Spraying Fruit Trees.

Time of Application	Effective Materials	Amount Per Hectare	Warnings	Other Pests Affected	Reference Number
Continue protectant fungicide if weather conditions warrant.	(1) **metiram** Polyram 80 DF (2) **captan** Captan 50 WP Captan 80 WP (3) **mancozeb** Manzate 200 80 WP Dithane DG	 6.00 kg 6.00 kg 3.75 kg 6.00 kg 6.00 kg	Alternation of fungicides is advisable.	Sooty Blotch, Fly Speck	01
It may be possible to reduce fungicide applications. See Reference 1.			Other diseases may not be controlled if fungicide applications are reduced. See Reference 1.		
Every 7-10 days	(1) **dinocap** Karathane 18.25 WD (2) **Dikar WP** (3) **benomyl mixes** Benlate 50 WP plus one of: (a) **metiram** Polyram 80 DF (b) **captan** Captan 50 WP (c) **mancozeb** Manzate 200 80 WP (4) **thiophanate-methyl** Easout 70 WP plus: (a) **captan** Captan 50 WP	 3.5 kg 7.5 kg 1.1 kg 3.25 kg 3.25 kg 3.25 kg 625 g 3.25 kg	Dinocap and benomyl are harmful to beneficial mites.	ERM Scab, ERM Scab Scab	03

TABLE 6H. QUICK DECISION CHART

Read the Label and Follow all Safety Precautions

Phenology	Pest	Most Susceptible Cultivars	Monitoring Procedure & Frequency of Observation	Action Threshold
First Summer Spray (continued)	Fire Blight	Idared, Lodi, Paulared	Monitor weather for temperature and rainfall. Check for shepherd's crook symptom.	Maintain protective program if following conditions are met: temperatures more than 18°C, history of fire blight in orchard, vigorous growth.
Other summer sprays	The following pests **MAY** require sprays for control. Continued monitoring for these pests is essential throughout the season. If pesticides are not applied for these pests, beware that other pests may be present. Check orchard at least once a week. See References for the occasional pests.			
	Tentiform Leafminer	All cultivars	Collect at least 2 leaves from each of 25 widely separated trees (50 total). Leaves should be selected from the midpoint of the current season's growth. Sample at least once per week.	4 or more mines per leaf on healthy trees; 2 or more mines per leaf on stressed trees.
	European Red Mite Two-Spotted Spider Mite	All cultivars, especially Red Delicious	Collect at least 2 leaves from each of 25 widely separated trees (50 total). Leaves should be selected at arm's length into the tree canopy. Sample at least once per week.	Early summer, 7-10 active mites/leaf and first sign of bronzing. Mid-to-late summer, 10-15 active mites/leaf or bronzing on the outside canopy.

For trees more than 5.5 m or less than 4.5 m high, adjust rates as indicated on page 7, Guide for Spraying Fruit Trees.

Time of Application	Effective Materials	Amount Per Hectare	Warnings	Other Pests Affected	Reference Number
Before rainfall with threshold	(1) **streptomycin sulfate** Streptomycin 17	 600 g/1000 L	Where strikes are observed, cultural controls may help. See Reference 2. Apply streptomycin sulfate immediately following hail injury.		02
When first tissue feeder of second generation appears (check for this event every 2-3 days in orchard)	(1) **methomyl** Lannate L	 6.75 L	This material is toxic to beneficial insects and predator mites. This spray is not needed on varieties harvested before McIntosh. Lannate has been associated with leaf injury when applied under adverse weather conditions. See Reference. Thorough coverage is essential. DO NOT USE MORE THAN ONCE PER SEASON.	CM, WALH, OBLR, Aphids	16
When the majority of mites are in nymphal stages.	(1) **dicofol** Kelthane AP-35 Kelthane 187.5 EC (2) **propargite** Omite 30 W	 4.5 kg 7.5 L 5.5 kg	Miticides work best when applied alone and in high volumes of water. Never apply dicofol more than once per season. These products are slow acting and control may not be apparent for 10-14 days after application.	Rust Mite	09

TABLE 6I. QUICK DECISION CHART

Read the Label and Follow all Safety Precautions

Phenology	Pest	Most Susceptible Cultivars	Monitoring Procedure & Frequency of Observation	Action Threshold
Other Summer Sprays (continued)	Codling Moth	All cultivars	Listen to local agriphone for pest activity. See Reference 7.	Not determined
	White Apple Leafhopper	IPM materials for control of the second generation are not available. See Reference 17. Early season control is preferred.		
	Woolly Apple Aphid	All cultivars	Examine pruning cuts, water sprouts and leaf axils for cottony colonies	If the colonies are moving into the vicinity of fruit clusters.
	Apple Maggot	All cultivars	OMAF operates a regional monitoring program for AM activity. Check traps (red balls and yellow boards) twice weekly. See reference 6.	Not determined
	Scab	All cultivars	If lesions present in orchard, see strategy listed under First Summer Spray.	

For trees more than 5.5 m or less than 4.5 m high, adjust rates as indicated on page 7, Guide for Spraying Fruit Trees.

Time of Application	Effective Materials	Amount Per Hectare	Warnings	Other Pests Affected	Reference Number
Consult agriphone	(1) **phosmet** Imidan 50 WP	3.75 kg		AM, SFC	07
					17
At threshold	Cultural practices. See Reference.				18
First catch in commercial orchards. Consult agriphone.	(1) **phosmet** Imidan 50 WP	3.75 kg	Repeated sprays for AM may be needed. Late in the season, this may only be required around the orchard periphery. See Reference 6.	CM, SFC	06
	See First Summer Spray		Be aware of intervals to harvest.		01

REFERENCE SECTION

Disease References

Reference 1. APPLE SCAB (*Venturia inaequalis*)

The fungus which causes apple scab has a fairly complex life cycle. Explanations of its biology and management practices to control apple scab are described in detail in the OMAF Factsheet, *Apple Scab*, Agdex 211/634, which is available at your local OMAF office.

Determining Infection Periods The fungus overwinters in the previous year's infected leaves on the orchard floor. In the spring, spores called "ascospores" are formed. These ascospores are released during periods of rain and infect the newly opening buds. Whether or not infection occurs is dependent upon both the length of the wetting period and the average temperature. This relationship is outlined in Table 7. Infections of new apple tissues by ascospores produced from last year's leaves are termed **primary infections**. Olive green lesions appear on new leaves 10-28 days after a primary infection has occurred. The length of time it takes for lesions to appear depends on the average temperature after infection. These lesions produce another type of spore, termed "conidia," or summer spores. The amount of inoculum increases substantially once conidia appear. These conidia are spread by splashing rain and wind, and re-infect the leaves and developing fruit if protection by fungicide is inadequate. This type of infection is termed a **secondary infection**. Conidia require slightly longer wetting periods than ascospores do to initiate infections (see Table 7).

Infections of either type will happen only if moisture is present for a long enough period of time at a specific temperature. For a primary infection to occur, two things must happen: ascospores must be **released** by rain, and once released, they must have a long enough wet period at a given temperature to **infect**. The factors that govern **release** (rain causing leaf wetness between the hours of 8 a.m. and 7 p.m.) are slightly different than those required for **infection** (leaf wetness for a long enough period of time at a given temperature, at any time of day or night).

For a secondary infection to occur, only leaf wetness for a long enough period of time at a given temperature is required.

The calculations required for determining primary infections are different than the calculations for secondary infections.

New research on some of the conditions needed for spore release, and infection, has required that some modifications be made to the Mill's system for determining infection periods.

Determining Wetting Periods for Primary Infections

Ascospores are not **released** to any significant extent from **7 p.m. until 8 a.m.** (eastern daylight saving time). Therefore, rain occurring between 7 p.m. and 8 a.m. will not initiate a primary scab infection period until 8 a.m., since released ascospores must be present on green tissue to initiate an infection. The calculations for the length of the wetting period would start at 8 a.m., continuing until the leaves are dry. For example, if it started to rain at 1 a.m. and the leaves dried at 10 a.m., the length of the wetting period was only 2 hours long (8 a.m. — 10 a.m.). If it started to rain at 1 a.m. and the leaves dried off at 11 p.m., the length of the wetting period is 15 hours (8 a.m. — 11 p.m.). If it rained at 9 p.m. and the leaves were dry at 6 a.m., no wetting period would be recorded.

A wet period starting between 8 a.m. and 7 p.m. could initiate an infection period as soon as wetting occurs, since ascospores can be released immediately. Therefore, calculations for the length of a wetting period which starts between 8 a.m. and 7 p.m. begins as soon as the leaves are wet, and continues until the leaves are dry. For example, if it started to rain at 11 a.m. and the leaves dried off at 10 p.m., the length of the wetting period is 11 hours (11 a.m. — 10 p.m.).

Table 7. Relationship of Temperature and Moisture to Apple Scab Infection*

Average Temperature °C	Hours of Wetting for Infection	
	Primary Season	Secondary Season
1-3	48 +	
4	36	
5	28	28
6	23	24
7	18	22
8	15	19
9	12	17
10	11	16
11	9	14
12	8.5	13
13	8	12
14	7.5	12
15	7	11
16	6.5	10
17	6	9
18	6	8
19	6	8
20	5.5	7
21	5.5	7
22	5.5	7
23	6	8
24	7	9
25	8	11
26	10	13
27	13	16
28	18	21

**Adapted from MacHardy and Gadoury 1989*

Determining Wetting Periods for Secondary Infections

Secondary scab occurs when conidia from primary lesions present on the tree are spread by splashing rain. As with primary infections, secondary infections only occur if moisture initiated by rainfall is present for a long enough period. Secondary infections can, however, occur day or night so all secondary infections are calculated from the beginning of the wetting period regardless of the time of day.

Once the length of the wetting period has been determined, calculate the average temperature during this interval and check Table 7 to see if the leaves were wet long enough for an infection to occur.

Early in the season, all calculations will be for primary scab. Once primary scab is established and lesions are

present, both primary and secondary infections are possible. This will require two different calculations for the determination of (primary and secondary) scab infection periods. Trees must be protected by fungicide if either calculation indicates that an infection has occurred.

The primary scab season lasts until all the ascospores in last year's leaves are released. This varies from year to year, but typically lasts until late June. Secondary scab can occur throughout the season once scab lesions are present in the trees.

Contribution of Intermittent Rains, Dews, Etc. to Infection Periods

Periods of dew or high humidity (over 90%) will also contribute to a wetting period, but are significant only if **preceded** by rain. For example, if it begins to rain at 5 p.m. and stops at 10 p.m., and the leaves remain wet all night with dew, the total wetting period is calculated from 5 p.m. until the dew dries the following morning.

If dew occurs at 11 p.m. and it rains at 9 a.m. the following morning, the wetting period is calculated starting at 9 a.m. until the leaves are dry.

Wet periods during an intermittent rain should be added together to determine an infection period unless separated by 10 hours or more of dry, sunny weather. For example, if leaves are wet at 3 p.m. and dry by 7 p.m., re-wet at 11 p.m. by dew and dry at 8 a.m., the total leaf wetness period is 4 hours plus 9 hours, or 13 hours.

The longer the wetting period over the minimum time required for an infection, the greater the severity of infection will be. For example, if the leaves are wet for 8 hours and the average temperature is 10°C, no infection has occurred (see Table 7, page 34). If, however, the leaves are wet for 15 hours at this temperature, a primary infection, but no secondary infection has occurred. At 20 hours, a primary infection as well as a secondary infection have occurred.

Fruit Infection

Recent studies have confirmed that as fruit matures, it takes a progressively longer wetting period for infection by apple scab to occur. Table 8 gives this relationship. Wetting periods required for scab infection of fruit are longer than those required for leaf infection. For orchards with only light primary leaf infection, the longer infection times required for fruit may be monitored only where fruit scab is of concern. It should be pointed out that leaf infection, if unchecked during the growing season, could result in a great deal of overwintering scab and heavy ascospore releases next year.

Table 8. Relationship of Temperature, Hours of Wetting and Weeks After Full Bloom to Secondary Apple Scab Infection of Fruit*

Average Temperature °C	Weeks After Full Bloom 1	5	10	15
	Hours of Wetting for 2% Fruit Infection			
10	12	26	37	45.5
12	10	21.5	31	38
14	8.5	18.5	26.5	32.5
16	7.5	16	23	28.5
18	6.5	14.5	20.5	25.5
20	6	13	18.5	23

**Adapted from Schwabe et al., 1984.*

Timing of Sprays Growers would be wise to invest in reliable weather monitoring equipment for their own orchard. A hygrothermograph recorder for temperature and relative humidity, and a leaf wetness recorder are essential for accurate monitoring of scab infection periods (see Table 15, Selected List of Monitoring Equipment Suppliers, page 58).

Although many agricultural offices maintain weather equipment at various orchard sites, weather and drying conditions can vary significantly from site to site. The difference of one hour of leaf wetness or one degree of temperature between orchards can mean the difference between having a scab infection period or not. Knowing whether or not there has been a scab infection period in your orchard will enable you to better time your sprays to prevent scab, or save you from spraying unnecessarily.

To time the first spray, growers should consider the long-range weather forecast, tree development and variety, and information on the percentage of ascospore release from last year's leaves. Ascospore maturity may vary widely with geographic location. The percentage of ascospore release and stage of maturity is usually monitored on a weekly basis by the Pest Management Advisor or Horticultural Crop Advisor in your area. This information is available on most agriphones.

Each grower must watch the development and growth of his trees to decide if the fungicide residue on the fruit and foliage is adequate during the growing season. Once trees have progressed beyond silver tip, all new tissue must be covered by fungicide to prevent an infection by scab. Generally, spray programs are based on the principle of protection, so growers must apply fungicides before infection periods occur.

By paying close attention to weather details and to the stage of growth at the beginning of the season, growers may be able to save at least one unnecessary fungicide spray. For example, if trees are at green tip, but none of the ascospores are mature, growers can delay the first fungicide application until mature ascospores are present. If, however, trees are at green tip and mature ascospores are present, growers will want to apply a protectant fungicide right away if the forecast calls for rain.

Other factors may make it possible for growers to delay the first fungicide. A very low incidence of scab in the orchard in the past year, plus no nearby wild trees acting as a source of ascospores, may delay the initial appearance of spores. In Table 7, all infection periods listed for primary scab are the minimum wetting periods at each average temperature required for infection of very susceptible cultivars, such as McIntosh. Less susceptible cultivars, such as Red Delicious, will develop less scab than susceptible varieties in the same infection period.

Cold weather (less than 5°C) during the early part of the season may delay ascospore release for up to 3 hours, resulting in longer wetting periods required for infection.

IF SCAB WAS PRESENT IN THE ORCHARD IN THE PREVIOUS SEASON, GROWERS SHOULD NOT DELAY THE FIRST FUNGICIDE SPRAY. If trees are protected against scab until all the ascospores have been released from last year's leaves (about late June — the end of the primary season), then scab will have been controlled for the year. If, however, trees do become infected and scab becomes established in the orchard (allowing for secondary infections of leaves and fruit), fungicides are required to control scab for the **entire** growing season.

Table 9. Retention, Redistribution and After-Infection ("Eradicant") Activity of Some Fungicides For Control of Primary Apple Scab (Ascospore Stage Only)*

Materials	Maximum After-Infection Activity			Retention	Redistribution
	6°C	12°C	17°C		
Benlate 50 WP (0.5 kg)	48 hr	24 hr	18 hr	p-f	unknown
Captan 50 WP (2 kg)	48 hr	24 hr	18 hr	p-f	f-g
Cyprex 65 WP (0.5 kg)	48 hr	24 hr	18 hr	g	g
Dichlone 50 WP (0.5 kg)	96 hr	48 hr	36 hr	p-f	p-f
Dikar WP (2 kg)	48 hr	24 hr	18 hr	g	g
Dithane M-45 80 WP (2 kg)	48 hr	24 hr	18 hr	g	g
Equal 65 WP (0.5 kg)	48 hr	24 hr	18 hr	g	g
Manzate 200 (2 kg)	48 hr	24 hr	18 hr	g	g
Phygon XL50 WP (0.5 kg)	96 hr	48 hr	36 hr	p-f	p-f
Polyram 80 WP (2 kg)	48 hr	24 hr	18 hr	g	g

p = poor; f = fair; g = good

**Adapted after New York (Geneva) data. These values were obtained from greenhouse tests; rates quoted are per 1000 L. Rate per hectare is 3 times rate per 1000 L. The after-infection activity of these fungicides may not be adequate to control primary apple scab in a commercial orchard. Be very careful and don't rely heavily on the after-infection activity if the maximum time interval for a given temperature is being reached. The after-infection activity is calculated from the start of the wetting period (see Determining Infection Periods, page 34).*

Apple Scab Control Under Adverse Weather Conditions Several consecutive days of continuous wet conditions and mild temperatures are common in the spring and are favorable conditions for apple scab infection to take place. It is often difficult to maintain sufficient fungicide on the trees to provide protection for the rapidly expanding foliage and fruit under such conditions.

If you feel your trees are not protected, it is better to apply a fungicide during a break in the rain, or even during a light rain, than not to spray at all. A fungicide having good retentive properties should be used at this time. For example, mancozeb has good retention and after-infection activity, while benomyl (Benlate) has good after-infection activity, but poor retention ability when applied to wet trees (see Table 9).

Strong winds can hamper spraying operations by causing fungicides to drift away from the intended target. Spraying at night, or early in the morning when winds are calm, can help reduce spray drift. Lowering the spray trajectory into the wind may also help, but growers should take extra care to make sure that the tree tops receive good spray coverage.

After-infection sprays may be required when protectant fungicides become too diluted to prevent the apple scab fungus from establishing itself on the foliage or fruit.

After-Infection Eradication Sprays An after-infection spray is one that is applied within a specific time after an infection period has begun. The length of time available to apply the fungicide so that it will work effectively depends on the product being used and the average temperature (see Table 9). When calculating after-infection activity, you must start counting the time interval from the **beginning** of the **infection** period. For example, at 6°C you would have to apply Captan within 48 hours of the **BEGINNING** of the **infection** period (please refer to "Determining Infection Periods" to calculate infection periods).

Do not entirely rely on after-infection fungicide programs to control scab. In order to use this type of spray program successfully, you need spray equipment capable of providing good spray coverage under adverse conditions as well as accurate temperature and leaf wetness information for your individual orchard. Reliable weather monitoring equipment is a must when relying on after-infection (kickback) activity of fungicides to control scab. After-infection sprays are usually considered emergency treatments to be used when the regular protectant program has been weak or ineffective, and scab is present on the trees. However, these programs may be used effectively by some growers on processing and less valuable cultivars.

Before applying a fungicide after an infection period has occurred, check its after-infection activity (see Table 9). If an infection has occurred, with temperatures averaging 20°C, scab lesions should become visible on the foliage and fruit in about 9 days, or in about 14-21 days if the average temperatures are 11°C or lower. As soon as scab lesions are visible, they may be controlled by following the instructions outlined in the following section, Deactivation of Established Scab Lesions.

Deactivation of Established Scab Lesions

Apple scab lesions that are visible on the foliage and fruit contain many spores capable of spreading the disease through secondary infection. The fungicides benomyl (Benlate), thiophanate-methyl (Easout), and dodine (Equal and Cyprex) have demonstrated good antisporulant activity **EXCEPT WHERE RESISTANCE IS PRESENT**.

In the past, growers have been able to obtain control of established apple scab because of the eradicant properties of these fungicides. Both dodine (Cyprex/Equal) and benomyl (Benlate) were effective products for the control of apple scab and because of this, were used intensively in season-long spray programs. Cyprex was used effectively for about 10 years, while Benlate was used only about 3

Table 10. Disease Resistance of Apple Cultivars

Cultivar	Apple Scab	Cedar-Apple Rust	Quince Rust	Fire Blight	Powdery Mildew
Red Delicious	S	R	VS	I	I
Golden Delicious	S	VS	VS	S	S
Empire	VS	I		I	S
Idared	S	S		VS	S
Jerseymac	VS	R		S	
McIntosh	VS	R	S	S	S
Mutsu	VS	S		I	VS
Northern Spy	S	S		I	S
Paulared	S	I		VS	S
Spartan	S	I		I	I
Scab-Resistant Cultivars					
Britegold	R	VS	VS	R	R
Freedom	R	R		R	R
Jonafree	R	VS	S	R	R
Liberty	R	R	S	I	I
Macfree	R	R	VS	I	I-S
Moira	R	I	VS	S	I
Murray	R	I	VS	I	
Nova Easygro	R	R		I	S
Novamac	R	R	VS		
Prima	R	VS	VS	I	I
Priscilla	R	R	VS	I	S
Redfree	R	R	S	I	I
Richelieu	R	VS	S		
Rouville	R				
Sir Prize	R	VS	VS	VS	I
Trent	R	I	VS	I	R

Disease Resistance: R = resistant; I = intermediate in susceptibility; S = susceptible; VS = very susceptible.

years before the first cases of resistant scab developed. Scab that is resistant to benomyl is also resistant to thiophanate-methyl (Easout). Resistance was suspected and confirmed after each of these products failed to control apple scab in orchards. A survey of apple scab samples in Ontario showed that about 50% were resistant. Resistance may be present even when these fungicides have never been sprayed. Therefore, the use of these fungicides is **not** encouraged.

Apple growers will have to continue to rely on the use of protectant fungicides to control scab. At this time, there are no alternatives for the eradication of established apple scab, unless growers have scab that is still sensitive to benomyl and thiophanate-methyl, or dodine.

If resistant scab organisms are not present in your orchard and apple scab lesions are visible, you can try to deactivate these tissue infections. Two sprays of benomyl plus a compatible protectant fungicide, or dodine should be applied at full rate 5-7 days apart as soon as scab lesions are observed. These materials reduce the number of spores produced in the lesions and should help to slow the spread of the disease. These eradicant sprays should be followed up with a regular protectant program.

Cultural Controls

Because a film of water on the infection site is necessary for scab to infect, practices which favor the unrestricted movement of air through the orchard are encouraged. Trees should be well pruned. When the orchard site has good air drainage, the number of possible infection periods can be reduced significantly because the foliage dries more quickly.

Commercial apple cultivars vary in their susceptibility to scab infections. Cultivars such as Cortland, McIntosh, Julyred, Jerseymac and Vista Bella are highly susceptible, whereas Red Delicious, Golden Delicious, Mutsu and Northern Spy are less so. All cultivars will become infected under conditions of high disease pressure, unless the variety is resistant to scab.

A number of apple cultivars are now available which are resistant to the apple scab fungus. If scab resistant cultivars are grown, no fungicides will be required to control apple scab. Some of the scab resistant cultivars are susceptible to other diseases, such as cedar-apple rust, quince rust, and powdery mildew, and several fungicide sprays may be required to control these diseases. Scab resistant cultivars vary in their susceptibility to fire blight. Some apple cultivars are resistant to several diseases (see Table 10). Although resistant cultivars are not readily available from Ontario nurseries, they may be propagated for you by request, or may be purchased from other provinces or the United States. Few of these varieties are suitable for long-term storage, or for the commercial fresh fruit market.

Summer Sprays

The end of primary scab season usually occurs during mid- to late-June, but this depends on the amount of rainfall received and the rate of breakdown of last season's

leaves. Consult the agriphone to determine when the end of the primary scab season occurs. After the end of the primary season has been announced, wait 2 weeks before checking your trees to ensure that scab is not present. It can take up to 14 days for lesions to appear following a scab infection period at this time of year.

If primary scab has been controlled in your orchard, the rates of fungicides may be reduced, and the interval between sprays may be lengthened for the remainder of the growing season. Growers should be very careful to check the leaves and young fruit thoroughly for the presence of scab lesions before reducing the fungicide spray program. It takes very few lesions to produce a major epidemic later on in the season if leaves and fruits are not protected. Therefore, the best areas to check are the leaves in the top of standard trees, or anywhere else where you feel that spray coverage may not be adequate.

If scab is not found, you may elect to eliminate fungicide applications entirely after the end of the primary season. You should be aware, however, that other summer diseases may become a problem in the absence of fungicide residues. (See Disease References, Reference 20. Sooty Blotch and Fly Speck.)

If scab lesions are found, you should maintain a full-rate fungicide program for the remainder of the season.

Reference 2. FIRE BLIGHT (*Erwinia amylovora*)

Life History

Fire blight is a bacterial disease. The bacteria overwinter in cankers on the tree. In the spring, bacteria in these cankers ooze onto the surface of the bark where splashing rain and insects pick up the bacteria and move them to the flowers and shoot tips. Oozing bacteria may then act as inoculum throughout the growing season.

Idared, Rhode Island Greening, Lodi, Jonathan, Tydeman's Red and Yellow Transparent are very susceptible to fire blight. Cultivars such as Red Delicious and Northern Spy rarely become infected. M9 and M26 rootstocks are also very susceptible to this disease.

Symptoms

Initial fire blight symptoms are watersoaking, wilting, and darkening of the blossoms. In Ontario, blossom blight symptoms do not always occur on apple trees. Shoot blight symptoms are more common. Shoots wilt at the tips, darken and finally dry out with the leaves still attached. This is commonly known as a shepherd's crook, a distinctive symptom of fire blight. Fire blight may extend from the shoots into larger branches, where cankers are formed. Cankers are identified by a discolouration of the bark, sunken tissue, cracking of the canker margin, and the presence of bacterial ooze on the canker surface.

Control

Fire blight control is best approached by maintaining good cultural practices, using streptomycin sulfate judiciously, and growing less susceptible cultivars. A combination of the following practices is suggested:

1. Choose a well-drained site, one which avoids wet conditions.
2. Use a balanced nutrition program relying on leaf and soil analyses. Avoid excessive nitrogen which promotes succulent growth.
3. Prune trees lightly to avoid succulent regrowth.
4. Remove alternate fire blight hosts, such as crab apple, hawthorn, mountain ash, and firethorn, from the vicinity of the orchard.
5. Do not plant susceptible apple cultivars next to susceptible pear plantings.

Where Fire Blight Occurs

1. Prune out overwintering cankers while trees are dormant.
2. Apply blossom sprays of 100 ppm streptomycin sulfate when weather conditions favor infection. Infection is more likely when temperatures are at least 18°C, humidity is high (more than 60%), and rainfall or heavy dew has occurred.
3. Patrol the orchard twice weekly in June and July removing early season infections. Tools should be disinfected between cuts with one part household bleach (6% sodium hypochlorite solution) in 4 parts water.
4. Post-bloom sprays of streptomycin sulfate are best applied prior to rainfall and can reduce further spread if fire blight is a serious threat.
5. Streptomycin sulfate sprays should be applied immediately after hail injury which has caused open wounds.
6. Bordeaux mixtures, applied during the dormant period, may help reduce the risk of infection (see Reference 5. Bordeaux Mixture, page 39).

WARNING Bordeaux mixture is phytotoxic and will cause leaf injury if applied later than green tip.

See OMAF Factsheet, *Fire Blight*, Agdex 211/634.

WARNING Fire blight is very easily spread by pruning. All diseased wood should be pruned out in the **dormant** season, before temperatures warm up and bacteria multiply. Cut or break off infected wood at least 45 cm below any discolored tissue. ALWAYS DISINFECT TOOLS AFTER EVERY CUT.

Reference 3. POWDERY MILDEW (*Podosphaera leucotrica*)

This fungus is one of many in the powdery mildew family. This species is specific to apple, pear and quince. Cultivars of apple most susceptible to this disease include Idared, Cortland, Paulared, Rome, and Jonathan. Other cultivars (e.g., Northern Spy, McIntosh) may get powdery mildew if the disease pressure is high.

Powdery mildew stunts shoot growth and may weaken or kill buds required for branching, which is especially critical in the development of young trees. If the blossom or young fruit are infected, fruit abortion or russetting may occur.

Life History

The fungus overwinters in buds infected during the previous year. Infected buds are more susceptible to cold and many will be killed when temperatures fall below –28°C. However, some of the dormant fungus may survive and begin to grow again when tree growth commences in the spring. Powdery mildew grows out of the bud and invades the new green shoots. Powdery white spores are produced, which are blown to leaves and fruit, and cause new infections.

Infection is favoured by high humidity (more than 90% R.H.) and temperatures between 18-27°C. Spores

will not germinate if they are immersed in water; so unlike most other diseases caused by fungi (including scab), leaf wetting is not conducive to infection. Under ideal conditions, the disease cycle can be completed in less than a week. Late-season infections of buds will allow the fungus to overwinter. See OMAF Factsheet, *Powdery Mildew of Apple*, Agdex 211/634.

Control

Fungicides for powdery mildew control must be applied **prior to infection**. Periods of high humidity are conducive to infection, so spores must be killed prior to these conditions.

Dikar, or combinations of benomyl plus another fungicide have worked well. These materials, or dinocap (Karathane) or thiophanate-methyl (Easout) plus captan, can be used for powdery mildew control. A 7-10 day spray interval may be necessary to obtain control on susceptible cultivars, even if scab sprays are not required. Often these special sprays are applied only to the most susceptible varieties. All of these fungicides, with the exception of Karathane, are effective against scab as well.

Sprays should be applied until the terminal buds have formed to prevent infections which will allow the fungus to overwinter. These controls must continue until fall on vigorously growing young trees.

Morestan, a pre-bloom miticide, will also aid in the control of powdery mildew.

Reference 4. RUST DISEASES

Life History

Cedar-Apple Rust (*Gymnosporangium juniperi-virginianae*)

The fungus overwinters as mycelium in small brown galls about 1-5 cm in diameter on the leaves of eastern red cedar trees (Juniper). During spring rains, the galls swell and orange gelatinous horns protrude from them. Often these spore-producing horns are quite evident on red cedars and at a quick glance may look like oranges hanging on the trees.

Generally, from tight cluster to the calyx stage of apple, spores are released from infected red cedar trees. Rust infection is most severe during long wet periods which occur between bloom and shortly after fruit set. Spore discharge begins when rain commences and continues as long as moisture is available. Weather conditions which cause primary apple scab infection will serve to spread rust, but rust infections can also occur during wet periods as short as 4-6 hours, or during periods of high humidity (greater than 85% RH). The horns are generally exhausted of all their spores by the middle or end of June.

Spores that land on the fruit or leaves of apple will germinate, penetrate, and infect the tissue if they receive a wetting period of 4-6 hours. The fungus infects the upper leaf surface of new apple leaves; leaves that are 3-4 weeks old tend to be fairly resistant to infection. The symptoms appear on the leaves and fruit about 14 days after the infection has taken place.

Quince Rust (*Gymnosporangium clavipes*)

The fungus overwinters as mycelium in spindle-shaped enlargements on the twigs and branches of red cedar. Once the red cedar is infected, the swellings remain a source of infection for several years, unlike the cedar apple rust fungus, which releases spores for only one year after which the galls wither and die.

Spores are produced from an orange gelatinous mass and travel to apple, where they initiate infections only on the fruit. Leaves are not infected by quince rust. Infections occur from pink until late June during periods of rain or high relative humidity. See OMAF Factsheet, *Cedar-Apple Rust*, Agdex 211/634.

Monitoring

Cedar-Apple Rust

This disease can be monitored by examining the leaves of red cedar hosts near orchards. Red cedar should be examined for galls and orange gelatinous horns from early May to mid-June. When these spore-producing galls are observed, protectant fungicide sprays should be applied in the orchard.

Infections in the orchard can be monitored by examination of leaves and fruit of susceptible varieties such as Mutsu, Idared, and Golden Delicious. Rust lesions on apple fruit and leaves will not spread to other apple trees.

Quince Rust

Several varieties of eastern red cedar (Juniper) are hosts of quince rust. The number of infections on red cedar can be determined by examining twigs and branches for spindle-shaped galls. The proximity and number of Junipers is as important as the number of galls on these trees. When spore-producing galls are found, protectant fungicide sprays should be applied to the orchard. After calyx, the fruit of Red Delicious, Golden Delicious, and Mutsu should be examined for infection. These are the most susceptible apple varieties grown commercially in Ontario.

Control

Ferbam, Dikar, Polyram or Dithane DG will control rust diseases.

Timing

Cedar-Apple Rust and Quince Rust

Maintain protection from tight cluster/pink until mid-June. Long wetting periods from bloom until just after fruit set are the most favourable conditions for fruit infection. In orchards with a history of the problem, an apple scab control program may not be enough to control rust diseases. Under light disease pressure or in cases of low incidence, a scab control program having fungicides suitable for cedar-apple rust control will be adequate.

Comments

Rust will not spread from apple tree to apple tree. Fungicides must be applied from May to late June, **before** rust lesions are visible on apple leaves or fruit.

Reference 5. BORDEAUX MIXTURE

Generally, Bordeaux sprays are recommended for dormant applications. The lime interacts with the copper sulfate to reduce the burning action (phytotoxicity) that would occur if the copper sulfate were used alone. For this reason, most Bordeaux mixtures are in a ratio of 3 parts lime to 1 part copper sulfate. The copper component provides most of the activity that Bordeaux has on fungal and bacterial diseases.

Bordeaux Formulas

In any Bordeaux formula, the numbers refer to kilograms of ingredients and the amount of water. These are always listed in the same order, with the copper sulfate first, then the lime, and the water last (e.g., Bordeaux 4-6-1000 L means 4 kg of copper sulfate and 6 kg of lime in 1000 L of water).

NOTE Bordeaux mixtures are extremely corrosive and, therefore, sprayers should be washed thoroughly after use. A protective coating of oil may help prevent the Bordeaux from bonding to the paint, thus making washing easier.

To Tank-Mix Bordeaux:

1. Start water flowing into the spray tank.
2. When the tank is about ⅓ full and the mechanical agitator is in operation, start washing the powdered copper sulfate into the tank through a screen with water from the supply hose. A wooden spoon is often helpful in working powdered copper sulfate through the screen. The screen is necessary to prevent large granules of copper sulfate from getting into the tank. Premixing copper sulfate with hot water has been shown to help the product dissolve.
3. By the time the tank is ⅔ full, all of the powdered copper sulfate should be in the tank. Then wash the lime (hydrated or builder's) through the screen, using the water-supply hose, into the copper sulfate solution in the tank. The lime should be diluted as much as possible before it meets the copper sulfate solution in the tank, so use lots of water to wash the lime through the screen. Pre-soaking the lime before adding to the tank may be preferable to washing powdered lime directly through the screen into the tank.
4. Keep the agitator running continously and apply the Bordeaux mixture immediately. Do not allow the mixture to settle out.

Insect References

Reference 6. APPLE MAGGOT (*Rhagoletis pomonella*)

Life History

The apple maggot (AM) is a major pest of apples in Ontario. Adult AM migrate to commercial orchards from nearby wild or abandoned hosts (e.g., hawthorn, crab apple, and plum). Apple maggots rarely overwinter in commercial orchards where insecticides are applied for control and all apples are picked up at harvest.

Apple maggots overwinter as pupae in the soil, and can survive as pupae for 2 to 5 years. The adult flies emerge from late June onwards, depending upon soil temperature and rainfall, and the peak flight occurs in August. AM remain active until the frost kills them. They lay eggs under the skin of the apple, where the larvae develop and burrow into the fruit flesh before finally dropping out onto the soil and pupating. There is usually one generation of AM each year, although in some years a few second generation adults may develop.

Monitoring

Apple maggot is monitored using visual traps consisting of two sticky red spheres and a sticky yellow board. Five sets of traps are placed in apple trees along the edge of the orchard to attract AM migrating into the orchard. The traps must be placed so that they are highly visible to AM. Other insects are also attracted to these traps and must be removed so that the traps remain visible and effective. For further information on trap placement, see OMAF Factsheet, *Apple Maggot*, Agdex 211/634.

Threshold

Because no AM injury is allowed on fruit, insecticides are recommended as soon as any AM are caught on traps in commercial orchards.

Control

Catches of AM on traps are used to determine the timing of the first spray and subsequent spray dates. The first spray is usually applied in early July and may coincide with insecticides applied for codling moth. The preferred material for AM control is phosmet (Imidan) which should control AM for 10-18 days, depending upon weather conditions and subsequent trap catches. Local spray recommendations can be obtained from the agriphone. If AM are caught in late August, a border spray covering the outer 6 to 8 rows should be applied. Sprays applied for AM should also control codling moth.

Wild hosts, such as apple and hawthorn, near the orchard should be removed because they are a source of AM (see Table 5, page 15).

Figure 2. Wing Patterns of Apple Maggot and Related Species.

Reference 7. CODLING MOTH (*Cydia pomonella*)

Life History

Codling moths (CM) overwinter as partially grown larvae in cocoons under bark on the trunk and pupate in early spring. The first CM adults emerge near the end of May or early June and lay eggs on apple foliage. The eggs hatch and the larvae move to the fruit.

Damage occurs as larvae enter the apple and bore to the core. When mature, the larvae exit from the apple. A distinguishing feature of CM damage is the brown frass in the larval tunnel and at the exit hole.

In most areas of Ontario, there is one complete generation of CM and a partial second in each growing season. For further information, see the OMAF Factsheet, *Codling Moth*, Agdex 211/634.

Monitoring

Codling moths can be monitored with pheromone traps, but their population trends are best seen when trap catches from several orchards are totalled. For this reason, growers can make better use of the information collected by OMAF for the region rather than for a specific site. Four traps are set out in representative orchards in each of the apple-growing areas. These traps are checked twice weekly by trained OMAF scouts.

Threshold

There are no thresholds for CM control. Insecticides are recommended in all commercial apple orchards.

Timing and Control

Trap counts and weather data are used to determine the first CM spray date. This information is collected by OMAF and is announced on the agriphone.

The first insecticide spray is timed for the peak egg hatch and is applied in early to mid-June, depending on geographic area. The insecticide recommended for this spray is azinphos-methyl (Guthion, APM) because it also controls other pests, like plum curculio, which are present at this time. The need for subsequent sprays will depend upon trap catches and pesticide residue levels, which are affected by the length of time since the last spray, the amount of rainfall, and the temperature. Listen to the agriphone for information on the need for these sprays in your area. Subsequent sprays to control CM should be phosmet (Imidan). Insecticides applied for CM also control apple maggot.

Reference 8. GREEN APPLE APHID (*Aphis pomi*)

Life History

Green apple aphid (GAA) tends to be a "flush feeder," generally preferring soft succulent tissue such as water sprouts and suckers. Like many aphids, GAA can reproduce without mating, making it easy for populations to increase dramatically in a short period of time. There are two types of GAA injury.

1. fruit discolouration due to sooty mold growth on GAA "honeydew" or sticky excrement; and/or
2. stunted terminal growth with excessive lateral growth or branching on young shoots.

For additional information, see OMAF Factsheet, *Green Apple Aphid*, Agdex 211/634.

Monitoring

GAA colonies are distributed unevenly in the orchard and problems do not occur every year. Weekly monitoring should begin at petal fall and continue until terminal buds set on vegetative shoots. Check at least 3 terminals from each of 10 trees for the presence of GAA. A terminal is considered to be infested if more than 100 aphids are present, or if aphids are continuous along the mid-ribs of any 3 leaves on the terminal. Beneficial insects usually suppress aphids, so be sure to identify predators such as lacewings, ladybird beetles and syrphids (see Table 3, page 8).

Threshold

Control sprays are only recommended if beneficial insects are absent, and:

1. fruit blemish from "honeydew" is imminent; or
2. more than 20% (6 out of 30) terminals are infested; or
3. if growth is jeopardized on young trees (especially the central leader).

Control

Pirimicarb (Pirimor) is recommended for GAA control. See warning.

NOTE Dormant oil sprays applied for scale control can also suppress GAA by killing overwintering eggs.

Timing Insecticides for GAA control work best when applied in high volumes of water before leaves curl. In most years, no sprays specifically for GAA are needed. When terminal buds set or "harden off," aphids move to more succulent hosts, and there is no need to apply insecticides for control.

WARNING Some countries impose a zero tolerance for Pirimor residues on fruit shipped from Canada. Check with your packer before applying this material.

If the grower is unable to use Pirimor, Thiodan 50 WP at 3.25-4.5 kg/ha can be used alternatively. Thiodan may also control white apple leafhopper.

Reference 9. MITES — EUROPEAN RED MITE (*Panonychus ulmi*), TWO-SPOTTED SPIDER MITE (*Tetranychus urticae*), APPLE RUST MITE (*Aculus schlechtendali*)

General Notes

Three species of mites can be pests in orchards. These are the European red mite (ERM), two-spotted spider mite (TSSM), and the apple rust mite (ARM). All mites have three life stages: egg, nymph, adult. The nymphs and adults are usually grouped together as "active" mites.

EUROPEAN RED MITES are usually the most serious of the three mite species. These reddish-coloured mites are present in apple trees all year long. In late summer and early fall, adult ERM lay red eggs on twigs and branches and in the calyx end of the fruit. Eggs remain on the tree until spring, and they begin to hatch around tight cluster.

Nymphs move to apple foliage where they feed on the leaves, mature to adults, mate and lay more eggs. ERM move from the cluster leaves in the interior of the tree to the growing shoots in the outer canopy as the season progresses. There can be 6-8 generations of ERM each year. The first few generations are the most synchronous, but by midsummer the generations overlap and all stages (eggs, nymphs, adults) are present at once.

When ERM feed on leaves, they cause a characteristic leaf injury called bronzing. Severely bronzed leaves become brown and brittle, which leads to reduced shoot growth, reduced fruit bud set the following year, and can interfere with fruit sizing. Slight bronzing inside the tree canopy does not seem to cause any lasting damage.

TWO-SPOTTED SPIDER MITES are pests of many crops. TSSM are harder to see than ERM because they are pale green or straw-coloured. They are easily distinguished from ERM by two dark spots on their backs. TSSM overwinter as orange-coloured adults beneath the tree. There are 3 to 5 generations each year.

In orchards with a clean herbicide strip, TSSM will attempt to overwinter beneath loose bark on the tree trunk and may be present in the tree canopy early in spring.

In all orchards, TSSM can overwinter and feed on broadleaf weeds in the ground cover, where they are usually kept in check by predators. If these predators are killed by insecticides, TSSM can become a problem and

move from the ground cover to the tree canopy. They cause damage similar to that of ERM (i.e., stippling and bronzing of leaves). Migration of TSSM into trees is most common in late July and August when weeds on the orchard floor dry up. Root suckers and brambles beneath the tree are good places for TSSM to build-up.

APPLE RUST MITES seldom cause a measurable loss in the orchard. Exceptions do occur, however, and miticides are sometimes needed for control. These mites can be beneficial in low numbers because they are an important food source for predatory mites when ERM and TSSM numbers are low.

ARM are very tiny — too small to see without a very strong hand lens (16 X). They are beige or tan in colour, and wedge or carrot shaped. They overwinter beneath scales of buds, emerging to feed on foliage as buds open in spring and have numerous generations a year. ARM feed on the lower leaf surface and tend to congregate around the leaf mid-rib. Prolonged feeding by unusually high populations of ARM (200-300 per leaf) can bronze the lower leaf surface, causing a leathery appearance. Rhode Island Greening and Northern Spy are especially susceptible to rust mites.

ARM are not controlled by oil sprays, but miticides applied for ERM and TSSM will also control ARM.

MONITORING, THRESHOLDS AND CONTROL

Monitoring procedures, thresholds, and recommended controls for mites change as the season progresses. It is important to have a mite control plan in mind before the season begins. There are three critical times for mite control:

(1) Early Season Control
(2) Calyx
(3) Summer Miticides

(1) EARLY SEASON CONTROLS — Superior Oil, Morestan, or Carzol. These miticides are recommended to control the first generation of European red mite.

Superior Oil

Monitoring Check prunings, twigs, and branches with a hand lens for small, round, red eggs. Most will be found on the lower, sheltered side of twigs and branches.

Overwintering ERM eggs will begin to hatch around the tight cluster stage of growth. Overwintering ERM eggs are red, whereas hatched ERM eggs are clear. Both can be seen on twigs and spurs. As ERM eggs hatch, mites move from twigs to developing foliage.

Thresholds There are no thresholds for control of overwintering ERM eggs, but Superior oil is recommended if eggs are easily found.

Timing The best timing for Superior oil for ERM is from half-inch green to tight cluster on McIntosh. It should be applied before ERM eggs hatch. Note that this timing is too late for control of scale insects, and that you should adjust the timing of an oil application for the major pest to be controlled.

Notes on Oil Superior oil is the best miticide available and should be considered the "first line of defense" against ERM. Its use is strongly advised where there is a history of mite control problems and/or where large numbers of overwintering eggs are observed. The best control is achieved with **dilute** applications of Superior oil in at least 2000-3000 L of water per hectare. Superior oil kills by suffocation, therefore coverage is important. If the correct rate of Superior oil is applied in this volume of water, the mixture in the spray tank will be a 2% solution of oil in water. Use the high rate of oil on standard trees. If this dilute application is properly applied, no further miticide should be needed until early July or later.

WARNING Make no more than one application of Superior oil per block per year. Some apple cultivars, such as Red Delicious, Mutsu, and Empire, may be sensitive to oil injury under certain weather conditions. **See warning on page 47, under scale insects.**

The development of mite resistance to miticides is a major concern in Ontario. The proper use of Superior oil will reduce the number of summer miticides and delay the development of resistance to these materials.

Morestan or Carzol

Apply Morestan or Carzol where Superior oil was not used pre-bloom, and the threshold for mites (5 to 7 active mites/leaf) has been reached. Morestan is an alternative miticide for oil-sensitive cultivars such as Red Delicious, Empire and Mutsu. These materials will also control TSSM, which overwinter in the ground cover and are not controlled by oil. However, TSSM are rarely present in the tree until later in the season.

Monitoring

To determine the number of mites per leaf, collect 25 leaves (5 from each of 5 trees) per block. Pick leaves from one arm's length into the tree canopy, or approximately halfway between the outside of the tree and the trunk. Avoid sampling close to the trunk only. Add the number of nymphs and adults of ERM and TSSM together to get the total number of active mites per leaf.

NOTE This sampling procedure is used for the first generation of mites and changes as the season progresses.

Timing and Threshold The ideal timing for application is when more than 50% of the overwintering eggs are hatched and there are 5-7 active mites per leaf. A computer program is used to predict 50% egg hatch based on local weather conditions. Call the local agriphone for updates on ERM egg hatch in your area.

Notes on Materials Morestan will control some overwintering mite eggs, but it is much more effective against nymphs. Carzol is not as effective on overwintering mite eggs as Morestan. **Morestan is registered for pre-bloom use only.** Applications in high water volumes are more effective than concentrate sprays. Do not use Morestan within 14 days of an oil application. Morestan will suppress powdery mildew (see Reference 3, Powdery Mildew). Carzol will also control white apple leafhopper nymphs.

WARNING Morestan applied within 3 days following frost (or near frost weather conditions) or prior to a long wetting period may result in fruit russetting. McIntosh, Spartan and Empire appear to be more susceptible.

Carzol is not a preferred material for IPM programs. Carzol is harsh on beneficial mites, beneficial insects, and

bees. Applications of Carzol should be limited to once a year or less, and applied before or immediately after bloom.

Miticides should always be applied alone rather than tank mixed. Alternation of miticides from different chemical families is advised whenever possible (see Chemical Families of Pesticides, page 56, and Notes on Resistance, page 11).

(2) CALYX — Apollo.

Apollo is recommended for control of the second or third generation of ERM. Where the overwintering population of mites (first generation) is high, oil or Morestan should be used as the first miticide.

Monitoring ERM nymphs which hatch from overwintering eggs will become adults and lay the first summer eggs sometime during late bloom or petal fall. The first few generations of ERM mites are usually synchronous (most of the population is at the same stage of development at any one time). Sampling for mites should be continued weekly.

Samples of 50 or more leaves should be collected from monitored blocks. Collect at least 2 leaves from at least 25 well-spaced trees of the same variety. Leaves should be picked at arm's length into the tree canopy. Red Delicious tends to support large populations of mites, and in most cases, this variety should be sampled. Pay particular attention to blocks where early-season controls were not applied.

Thresholds Apollo is recommended when there are 2-3 active mites per leaf, PLUS EGGS.

Timing Apollo controls eggs and newly-hatched nymphs but works best on eggs. Therefore, the best timing for Apollo is when most of the mites are in the **egg stage**, and the number of adult mites is very low (i.e. no more than 3 active mites per leaf).

Notes on Apollo Apollo is toxic to eggs of the European red mite (ERM) and the two-spotted spider mite (TSSM). Adult ERM and TSSM are not controlled by Apollo. Adult mites present at the time of application will continue to feed for 1-2 weeks until they die of old age. Some bronzing may occur if adult mites are numerous.

Apollo is a very persistent miticide. It is relatively rainfast. However, be sure it has time to dry on the trees before a rain.

WARNING

Spray coverage Apollo kills mite eggs. Because eggs are stationary they must come in contact with the spray. Good spray coverage is even more essential with Apollo than with other miticides. At least 100 gallons of water/ac or 1100 litres of water/ha. are recommended for Apollo applications.

Resistance Apollo is a long-lasting miticide and many generations of mites may be exposed to Apollo residues from a single application. This increases the chance of mites developing resistance to Apollo. Mite resistance to Apollo has been reported where the product has been over-used.

In order to delay or prevent the development of resistance to Apollo, it is important to take a sensible approach to resistance management from "Day One":

(1) Only use Apollo once a year.

(2) Only use the recommended rate (300 mL/ha).

(3) Apply Apollo only when the threshold is reached: 2-3 active mites per leaf, PLUS EGGS.

(4) Do not apply Apollo when high numbers of **active** mites are present (i.e. more than 3 active mites per leaf).

(3) SUMMER MITICIDES — Omite or Kelthane.

These miticides are recommended for mite problems in late June, July, and August.

Monitoring Samples of 50 or more leaves should be collected weekly from monitored blocks. Collect at least 2 leaves from at least 25 well-spaced trees of the same variety. Leaves should be picked at arm's length into the tree canopy. Red Delicious tends to support large populations of mites and, in most cases, this variety should be sampled. Mites commonly occur in greater numbers on trees in sheltered areas, or next to dusty roads, but be sure to sample from all parts of the block.

TSSM often build-up on broadleaf weeds and sucker growth beneath the tree. They frequently move into the tree canopy in mid- to late-summer. Check closely for these mites with a hand lens. Because they are paler in colour, they are more difficult to see than ERM. Include both TSSM and ERM in the count to determine total mites per leaf in the sample.

Thresholds and Timing Thresholds for mite control vary with the time of year. In early summer (June and early July), apply miticides at 7-10 active mites per leaf, or at the first sign of bronzing. If the threshold is reached, but there are more eggs than active mites present, delay application until 50% of the eggs have hatched. In mid- to late-summer (late July and August), apply miticides when there are 10-15 active mites per leaf, or when bronzing appears in the **outer** tree canopy.

These miticides should be directed towards the nymph stage of mites; adults and eggs are harder to control. The ideal timing of miticides is when 50% or more of the mites in a sample are nymphs rather than eggs or adults. As nymphs and adults are difficult for the untrained eye to distinguish, leaf samples should be collected regularly to determine when eggs are being laid and hatching into nymphs.

Influence of Temperature on Mite Development The development of mites is related to temperature: the warmer it is, the faster mites hatch, mature, and reproduce. Table 11 can be used as a guideline to predict ERM development in the field. Note that the temperatures given are **average** daily temperatures.

Table 11. Effect of Temperature on European Red Mite Development

Avg. Temp.	Egg Stage	Hatch to Adult	Total Time
°C	Days	Days	Days
13	19	21	40
15.5	16	14	30
18	11	10	21
21	8	7	15
24	6	4	10
27	4	3	7

Note on Materials The miticides recommended for summer mite control are Kelthane and Omite. These are fairly slow-acting materials, so results may not be noticed until 7-10 days after an application is made. These miticides are more effective in warm, dry weather rather than during cool or rainy spells, so if the weather is cold and wet, delay spraying.

Kelthane Resistance to Kelthane may be a problem where this material has been used repeatedly in the past. **Never apply Kelthane more than once a year**, and limit applications to once every two years if possible.

Omite Omite works best in warm weather, i.e., when the average temperature is greater than 20°C.

RESISTANCE MANAGEMENT

Mites are a very serious problem in Ontario, and the number of miticides available is limited. Oil and Morestan are limited to pre-bloom use. Carzol, if used, should be restricted to early season applications. The potential for ERM and TSSM damage is greatest during the hot summer months of July and August. Overuse of Kelthane and Omite at these times could lead to the rapid development of resistance in mite populations. To make the best use of the available products while placing minimal pressure on any one material, the following guidelines are recommended:

1. Use one of the recommended miticides for early season mite control. Oil is the best choice; mite resistance to this material is not likely to develop.
2. Always alternate summer miticides. Never apply the same material twice in a row.
3. Apply miticides only when the threshold for control is reached.
4. Many mites live on the lower surface of leaves in the inner tree canopy. When applying miticides, increase water volumes and decrease travelling speed in order to ensure thorough coverage of these hard-to-reach areas.

The Importance of Conserving Beneficial Mites and Insects

Before chemical pesticides were widely introduced at the end of the 1940's, mites were very rare pests on fruit crops. They were almost completely regulated by their natural enemies, mostly beneficial mites and some insects. Many beneficial mites, such as *Amblyseius fallacis*, have become resistant to some common orchard pesticides and can control ERM and TSSM in most years. Such pesticides are compatible with IPM because they allow the beneficial mites to survive while controlling the pest mites.

In recent years, apple growers in Ontario have been forced to apply pesticides that are not truly compatible with IPM. Beneficial mites and insects have been reduced in number by these toxic materials, causing an increased problem with pest mites. Other orchard materials, such as carbaryl (Sevin), that are applied for cultural purposes can also have a devastating impact upon beneficial species.

A recent survey of 112 Ontario apple orchards revealed that over 75% still have beneficial mite populations surviving in them, but often in low numbers. If the IPM methods shown in this manual are employed by growers, beneficial mite numbers may again increase and provide free mite control for part, or all, of the season.

Reference 10. MULLEIN BUG (*Campylomma verbasci*)

General Notes and Damage

Mullein bugs (MB) are beneficial insects most of the year, when they act as predators of mites, aphids, and leafhoppers. However, mullein bugs may feed on fruit for a brief period after petal fall. Damage is often localized, but it may be quite severe.

Life History

Mullein bugs overwinter as eggs laid in bark of last season's growth. Eggs hatch during bloom and the nymphs feed on a variety of insects and mites. At petal fall, MB nymphs may (or may not) feed on young fruit. Most fruit injury occurs at the calyx stage of fruit development. Initially, injury appears as a tiny pin prick on the fruit surrounded by a water-soaked area which is not easily noticed. As the fruit enlarge, the MB injury forms a raised pimple on the surface of the fruit. Mullein bug damage is most serious in early cultivars and Red Delicious, Golden Delicious and Northern Spy, although injury to McIntosh is becoming more common. Much of the MB injured fruit will drop with the June drop.

Monitoring

Begin monitoring for MB nymphs during bloom and continue **at least** once a week until 2-3 weeks after calyx. Mullein bug nymphs are very small (smaller than an adult aphid) and light green in colour. They move very rapidly when disturbed. Nymphs can be detected by limb tapping. A tapping tray and a rubber stick or hose are necessary equipment for tapping (see Figure 1, page 12).

Sample at least 25 branches per block and one branch per tree. Tap each branch sharply 3 times while holding the tray below the branch. Check the tray after tapping each branch. Mullein bug nymphs are often present in fruit clusters, so tap branches having bloom or fruit rather than vegetative growth. Concentrate on sampling in blocks of Red Delicious, Golden Delicious, and Northern Spy, as well as blocks where MB has been a problem in the past.

Threshold

There are no scientifically proven thresholds for MB control. However, a threshold of 3-5 nymphs per 25 tapped branches has been used successfully in Ontario. If large numbers of aphids or mites are present, it may be possible to increase the threshold.

Control

Diazinon will provide good control of MB. Diazinon is very toxic to beneficial insects and mites and will disrupt an integrated program. It should be applied only to blocks where the threshold is reached.

The application of azinphos-methyl (Guthion, APM) at petal fall or calyx may suppress MB, but **will not provide adequate control once the threshold is reached**.

Timing

Diazinon should be applied as soon as the threshold is reached. Mullein bugs are easier to control when they are young. Considerable MB injury can occur in a short time.

WARNING Diazinon may not be needed if methomyl (Lannate) was used for tentiform leafminer control at calyx. Pyrethroids applied at petal fall for tentiform

leafminer may provide short-term control of MB, but continued sampling for MB is necessary.

Notes on Diazinon Diazinon will also control spring-feeding caterpillars and will suppress aphids. Diazinon does not provide continued control of plum curculio if pressure from this pest is high.

Reference 11. PLANT BUG COMPLEX

Tarnished Plant Bug (*Lygus lineolaris*)

Tarnished plant bugs (TPB) overwinter as adults. They become active when temperatures warm up in the spring (greater than 16°C). Peak activity of TPB usually occurs during bloom.

There are 2-3 generations of TPB each year, but it is only the overwintering adults that damage developing blossoms and young fruit. Feeding prior to bloom may cause buds to abort or may prevent fruit set. Damage to the fruit can occur from bloom until the apples are approximately ½" in diameter. Sometimes a clear, sticky ooze can initially be seen at the site of injury. Damage which occurs during or after bloom appears at harvest as small surface scars, or as deep conical depressions with a narrow central hole. Most injury cause by TPB occurs at the calyx end of the fruit. Longitudinal sections cut through these depressions often show them to extend to the core or calyx (see Figure 3, page 45).

Apple Red Bug (*Lygidae mendax*), **Green Apple Bug** (*Lygocoris communis novascotiensis*)

Both species overwinter as eggs on the apple trees. Eggs hatch by full bloom. Damage to apples is caused by young nymphs feeding on the apples at calyx.

Apple red bug injury appears as areas of smooth russetting at harvest. Green apple bug injury appears as raised, bumpy russetted areas on the fruit.

Monitoring

There are no effective methods for monitoring these insects. Monitoring plant bug activity is very difficult because they are highly mobile and secretive. There are no effective traps. Damage to buds appears as sap or ooze, but may not always be evident. Overwintered TPB adults can sometimes be seen on dandelion or chickweed growing in the orchard in the spring and can be detected by using a sweep net.

Tarnished plant bug injury is more likely to occur if: there is heavy weed growth (especially vetch, chickweed, and dandelions); it is a warm, dry, early spring; and there is an extended bloom period.

Control

Plant bugs are usually controlled by pre-bloom or calyx sprays for other pests, and specific sprays are not usually required. Tarnished plant bug injury is common, and it is not unusual to see 1-2% injury at harvest.

Weeds act as alternate hosts for TPB, so it is recommended that they be kept to a minimum in orchards with a history of TPB damage.

Do not apply herbicides from bloom to calyx because killing weed hosts encourages TPB adults to move into apple trees, thus causing increased damage.

Where excessive injury has occurred in the past, dimethoate (Cygon) or azinphos-methyl (Guthion or APM) may be required before bloom.

It is difficult to control all plant bug damage in an orchard, therefore 1-2% damage at harvest should be considered acceptable.

WARNING These insecticides are very toxic to bees.

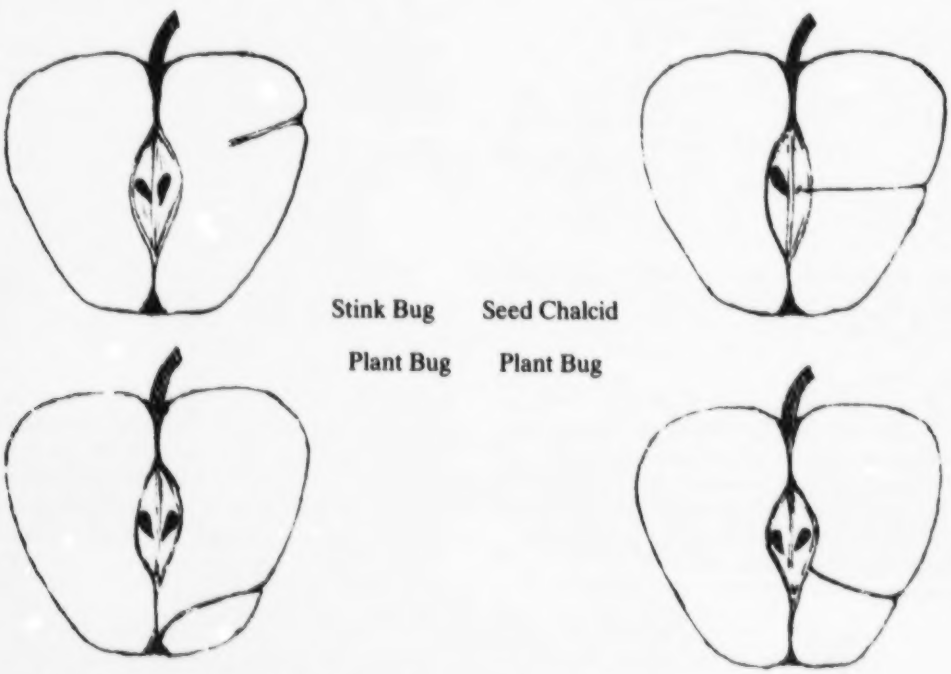


Figure 3. Distinguishing Injury of Seed Chalcid, Plant Bug and Stink Bug

Reference 12. PLUM CURCULIO (*Conotrachelus nenuphar*)

General Notes

The plum curculio (PC) is a pest of pome (apple and pear) and stone fruits. Few orchards have resident populations of PC. Most damage occurs when adult PC move into orchards from overwintering sites.

Life History

Adult PC overwinter in hedgerows and woodlands adjoining the orchard. The adults are about 5 to 6 mm long, dark in colour with a long snout and a bumpy abdomen. In the spring (near bloom) they move into the orchard. One generation occurs each year. Quite often, damage on wild hosts occurs 3-4 days before it occurs in a commercial orchard.

The adults cause two types of damage. Feeding injury occurs in the spring and late summer. It is characterized by small (less than 1 mm), "D" shaped holes in the fruit.

The other type of injury occurs shortly after bloom when the PC lay eggs in the fruit. This injury is characterized by a half-moon- or crescent-shaped scar. Infested fruit will drop to the ground and the larvae will develop inside the fruit. Mature larvae will exit from the fruit and enter the soil to pupate. Any fruit remaining on the tree will be misshapen at harvest.

Adult PC emerge from the soil from late July to early October, when they may feed briefly on apples and then seek overwintering sites in late September through early October.

Monitoring

Adults are difficult to find and monitoring for their activity consists of looking for injury (as described above) on the fruit.

First injury is more likely to occur when temperatures average 13-18°C for three days or 24°C for two days and following a rainfall. In many years, this coincides with the end of bloom (McIntosh cultivar).

Wild hosts that are near overwintering sites around the orchard perimeter should be checked twice weekly from petal fall to the time of the first codling moth spray, as this is where the first injury usually occurs. Wild hosts include abandoned apple, plum, and cherry trees. A fresh scar (less than one day old) is green while older scarring is brown.

Injury from PC is often most serious in the outer few rows of the orchard bordering on overwintering sites and is particularly serious near wild hosts.

Thresholds and Control

A border spray of azinphos-methyl (Guthion, APM) is recommended where injury is observed in the orchard or on nearby wild hosts, or where PC has been a problem in the past. A good border spray consists of spraying the outer 4 to 6 rows of the orchard. A repeat application may be needed if new injury is found 7 days after the first spray. This application will often coincide with the first codling moth spray.

WARNING Border sprays are only effective for PC and will not control other early-season pests.

Reference 13. ROSY APPLE APHID (*Dysaphis plantaginea*)

General Notes and Damage

Rosy apple aphids (RAA) overwinter as eggs. These eggs hatch early in the growing season. Young RAA are greenish in colour, but acquire a purple-red hue as they mature and develop a powdery white covering.

RAA feed on plant juices. Damage by RAA appears as stunting and bunching of fruit clusters. Affected leaves are tightly curled or puckered.

Monitoring

Check weekly for RAA, beginning at tight cluster and continuing until late June. Cortland, Idared and Red Delicious are good cultivars to monitor for RAA infestations. Examine 10 fruit clusters from each of 10 trees (standard), or 5 clusters from each of 20 trees (dwarf) for the presence of RAA. A cluster is considered infested if more than 20 aphids are present. Check the interior portion of the tree because first RAA activity usually occurs there. Be aware of the presence of beneficial predators in any clusters as they may make chemical controls unnecessary. Syrphids and ladybird beetles are good aphid predators.

Threshold, Control and Timing

Chemical control is recommended if more than 10 fruit clusters of the 100 examined are infested and no predators are identified.

Apply pirimicarb (Pirimor) in high volumes of water, before leaves curl tightly.

Note Dormant oil sprays applied for scale control can also suppress RAA by killing overwintering eggs.

Notes on Materials Pirimor will also control young white apple leafhopper and woolly apple aphids if they are present.

WARNING Some countries impose a zero tolerance for Pirimor residues on fruit shipped from Canada. Check with your packer before applying this material.

Reference 14. SCALE INSECTS — SAN JOSE SCALE (*Quadraspidiotus perniciosus*), EUROPEAN FRUIT SCALE (*Quadraspidiotus ostreaeformis*), OYSTERSHELL SCALE (*Lepidosaphes ulmi*)

Three major scale insect pest species are present in Ontario: San Jose scale (SJS), European fruit scale (EFS), and oystershell scale. Lecanium scale (*Lecanium sp.*) is also found in some orchards. Each species may damage apples by causing direct injury to the fruit, or by reducing tree vigor through trunk and limb infestation. Control tactics for all three species are similar.

Scales must be detected early before the population can become well established on the tree. SJS has 2 generations and EFS 1 generation each season. These scales live primarily on large scaffold limbs of trees with rough bark. Young crawlers move out to fruit-bearing limbs during the growing season. Since scale crawlers may be spread by the wind, infestation of young trees near older scale-infested trees can be a serious problem.

Monitoring

Most growers detect scale by noticing fruit injury at harvest: small, red measles-like spots on the fruit, usually near the calyx end. In many cases, the injury will first appear in late July — early August. Pesticide applications **do not effectively control** crawlers because they will emerge over a 10- to 12-week period.

Additional checks for scale include twig and bark examinations during the entire year, especially during dormant pruning. On wood, scale infestations will appear as grey, rough sandpapery areas. Scraping beneath this coating and removing the bark often will reveal stain spots. Purplish-red stains are caused by SJS insects, while EFS leave brown stains.

Thresholds

No economic thresholds exist and, in most instances, any fruit injury at harvest will make a control spray the following spring necessary.

Control

The use of Superior oil once every 3 to 4 years is suggested to prevent the build-up of damaging populations. High populations of scale insects require treatment for 2 or 3 consecutive seasons to achieve adequate control. Scale insects prefer to lodge below rough bark and this makes high-volume spraying essential to ensure thorough coverage. Superior oil is only effective when applied so that it runs beneath the rough bark. Superior oil does not kill by chemical action; instead, it must completely cover the scale and exclude air, thereby suffocating the insect. **Incomplete coverage** will allow the scale to continue to breathe and survive.

Generally, 2000 to 3000 L of water per hectare is needed to give satisfactory results. Greater volumes of water may be required to thoroughly cover large standard trees. Superior oil should be used just before the tree breaks dormancy when the scale will only have a small wax covering. Delaying until green tip often results in poor scale control, because the scales have built up a thicker wax covering by this time.

NOTE Superior oil works best when applied at temperatures above 4°C. Calm conditions and a slow travel speed during oil application will improve chances of successful scale control.

WARNINGS Superior oil may cause bark blistering on Red Delicious, Mutsu, and Empire. This type of injury is usually associated with the following conditions:

1. Cold temperatures during, or near, the time of application. Frost either 48 hours before or after Superior oil sprays may cause injury. **This condition may predispose all cultivars to injury.**
2. Trees in poor vigour. Winter injury, poor growth or an excessive crop during the previous season can leave trees weakened and sensitive to damage.
3. Young trees with mostly immature bark (i.e., green wood). Most trees less than 5 years of age fit into this category.
4. Repeated annual applications of Superior oil.

Reference 15. SPRING-FEEDING CATERPILLARS

General Notes and Damage

The spring-feeding caterpillar (SFC) complex is made up of several species of leafrollers and fruitworms, cankerworms and bud moths. Each insect has its own biology and life cycle, but all are present in the spring when they feed on foliage and sometimes on developing fruit.

Leafrollers, such as the red-banded leafroller (RBLR) (*Argyrotaenia velutinana*), are common in unsprayed orchards and can be destructive in commercial sites.

Most leafroller larvae have a yellow-green or green body with a distinct brown or black head capsule. Leafrollers can feed on both fruit and foliage. They have a habit of webbing or rolling leaves together as they feed. Unless the trees are very small, leafroller damage to foliage is generally insignificant. However, fruit clusters adjacent to leaves may also be attacked in the spring. Damaged fruit will either drop or become deformed as the apple grows around the injury. Some leafrollers have 2 generations each year. Larvae of the second generation are active in August and September, when they feed on the surface of maturing fruit.

A common leafroller found in orchards is the **oblique-banded leafroller** (OBLR) (*Choristoneura rosaceana*). OBLR larvae are green with black or brown heads; 1st-3rd instars (younger larvae) have black heads, 4th and 5th instars (older larvae) have brown heads. They usually wriggle violently when disturbed.

Green fruitworms (GFW) are green caterpillars which often have white speckles or stripes. Larvae may be present from pink until 3-4 weeks after petal fall. Young larvae feed on flower parts and new leaves, while older larvae feed mainly on small fruit. GFW feeding injury on fruit is characteristically deep, as opposed to the shallower feeding of leafrollers.

(1) TIGHT CLUSTER TO FULL PINK

Monitoring

Insecticides applied for tentiform leafminer (TLM) will usually control SFC. Therefore, monitoring efforts should be directed towards blocks where TLM sprays will not be applied.

Spring-feeding caterpillars feed on a variety of deciduous plants, including hardwoods, wild fruit trees, wild raspberries, etc. Infestations are most likely to occur in blocks or orchards adjacent to woods, bush, or hedgerows. Check these blocks and border rows first for caterpillar injury. Some leafrollers can suspend themselves on silken threads which carry them throughout the orchard with the breeze. Although infestations are more noticeable and severe at the orchard periphery, small larvae will easily spread some distance into the orchard.

Spring-feeding caterpillars are well camouflaged, and their presence is best detected by their feeding injury on foliage and by the presence of frass.

Green fruitworm will chew holes in leaf tissue and feed on fruit buds and clusters. They can sometimes be detected by shaking tree limbs to jar larvae from the foliage onto a tapping tray (see Monitoring Equipment and Techniques, page 11). Leafrollers generally web several leaves of a fruit cluster or growing shoot together and feed within this shelter. Monitor for spring-feeding caterpillars by checking 10 shoots from each of 10 trees (100 shoots in total). Webbing, frass, and chewed leaves are good indications of caterpillar activity. Leafrollers feeding on shoot growth sometimes create a "rat-tail" appearance; look at terminals in the upper portion of the tree.

Pheromone traps are available for monitoring adult moths of some leafroller species (e.g., OBLR, RBLR).

Trapping adults of one or two species does not provide information on the level of damage expected, nor does it provide information on the other species present. The total number of moths caught in 4 or 5 orchards in an area will give a better indication of moth activity than the catch from a single orchard. Pheromone trap catches are most useful for timing OBLR sprays.

Threshold and Control

Controls are recommended if 12-15 larvae are found on a sample of 100 shoots.

Azinphos-methyl (Guthion, APM) should be applied before bloom if the threshold is reached. Leafrollers and fruitworms are easier to control when they are small.

Notes on Materials Azinphos-methyl (Guthion, APM) applied pre-bloom will also suppress tarnished plant bug.

WARNING Do not spray insecticides during bloom, or when bees are present in the orchard. This spray is not needed where a pyrethroid was sprayed for TLM.

Special Notes on OBLR Control

Recent field experience indicates that although azinphos-methyl applied pre-bloom adequately controls overwintering larvae (2nd and 3rd instars), low levels of resistance have been detected. The young larvae of the first summer generation can be controlled by the first codling moth spray (provided that it is azinphos-methyl). The date of this spray may be adjusted by 2-3 days to coincide with 7-10 days after the initial "shoulder" of OBLR adult activity in traps (see Figure 4, page 49). If OBLR trap catches become high 10-14 days after the first spray, a second application of azinphos-methyl will be necessary. Do not extend intervals to more than 14 days between sprays.

Second generation adults and larvae are controlled by summer sprays for apple maggot and codling moth. Where OBLR has been a problem in the past, a special spray of methomyl (Lannate) may be applied to control young (1st-3rd instars) larvae. This spray is only needed for high infestations that were not previously controlled by azinphos-methyl. This spray should be applied 20-25 days after the initial upswing of adults caught in OBLR pheromone traps. Consult a Pest Management Advisor or a Horticultural Crops Advisor for the timing of this spray in your orchard. The OBLR is most dif cult to control in the Niagara area, where low levels of resistance to organophosphorus insecticides is suspected.

(2) CALYX

If no insecticide has been applied for SFC or TLM control, check closely for caterpillars. After petal fall, when fruit begins to set, significant, irreversible damage to fruit can occur if caterpillars are not controlled.

Monitoring, Timing and Thresholds

This is the same as for Tight Cluster to Pink.

Notes on Materials Azinphos-methyl, applied at petal fall, will help suppress tarnished plant bug, plum curculio, and mullein bug.

Reference 16. TENTIFORM LEAFMINER (*Phyllonorycter blancardella*)

General Notes

The tentiform leafminer (TLM) is an indirect pest which only attacks foliage. There are 3 generations a year. Leafminers overwinter as pupae in leaf litter and adults begin to emerge in April or early May. Emergence can continue for 4-5 weeks, depending on temperature. Eggs are laid on the lower leaf surface, usually in sheltered, lower portions of the tree. Eggs hatch and the larvae mine directly into the leaf. Young larvae feed on leaf sap and are called sap-feeders. Their mines are only visible on the lower leaf surface. After a period of sap-feeding, the larvae begin to chew holes in the leaf tissue. These mines are visible from the upper leaf surface and are called tissue-feeding mines. Tissue-feeders cannot be controlled by insecticides.

Healthy apple trees can tolerate 7-10 mines per leaf at harvest. The unmined portion of the leaf can compensate for the loss of leaf tissue. However, very high numbers of mines per leaf may cause apples to prematurely ripen and drop. Fruit drop due to leafminer damage is usually associated with other tree stresses such as drought, mite damage, a very heavy crop, or poor vigour. When fruit drop does occur, it is difficult to isolate a single cause. McIntosh trees are more likely to drop their fruit than Red Delicious or Northern Spy having an equal number of mines per leaf.

Monitoring procedures and recommended controls for TLM change as the season progresses.

(1) TIGHT CLUSTER, PINK OR PETAL FALL (Prior to egg hatch)

WARNING All materials listed for TLM control at this timing belong to the same chemical family (pyrethroid insecticides). **ALL PYRETHROIDS ARE VERY HARSH ON BENEFICIAL INSECTS AND ARE EXTREMELY DISRUPTIVE TO AN IPM PROGRAM.** Continued use of these materials can cause outbreaks of mites and aphids. **Never** apply pyrethroids more than once a year.

Monitoring

Adults Pheromone traps for TLM adults can **only** be used to indicate when adults are flying. It is not possible to predict the need for, or timing of, insecticides based on the numbers of TLM caught in these traps. For more information on trapping TLM, refer to the OMAF Factsheet, *Spotted Tentiform Leafminer*, Agdex 211/624.

Eggs and Larvae Monitoring TLM eggs is necessary to determine if an insecticide is needed. In early spring, moths lay small, yellowish eggs on the lower leaf surface. These eggs are difficult to see, even with a 10X or 16X hand lens. However, a hand lens is a useful tool for detecting TLM when large numbers of eggs are present. When egg counts are below the threshold, **a microscope is necessary for an accurate count**.

An adequate sample for TLM eggs consists of sampling

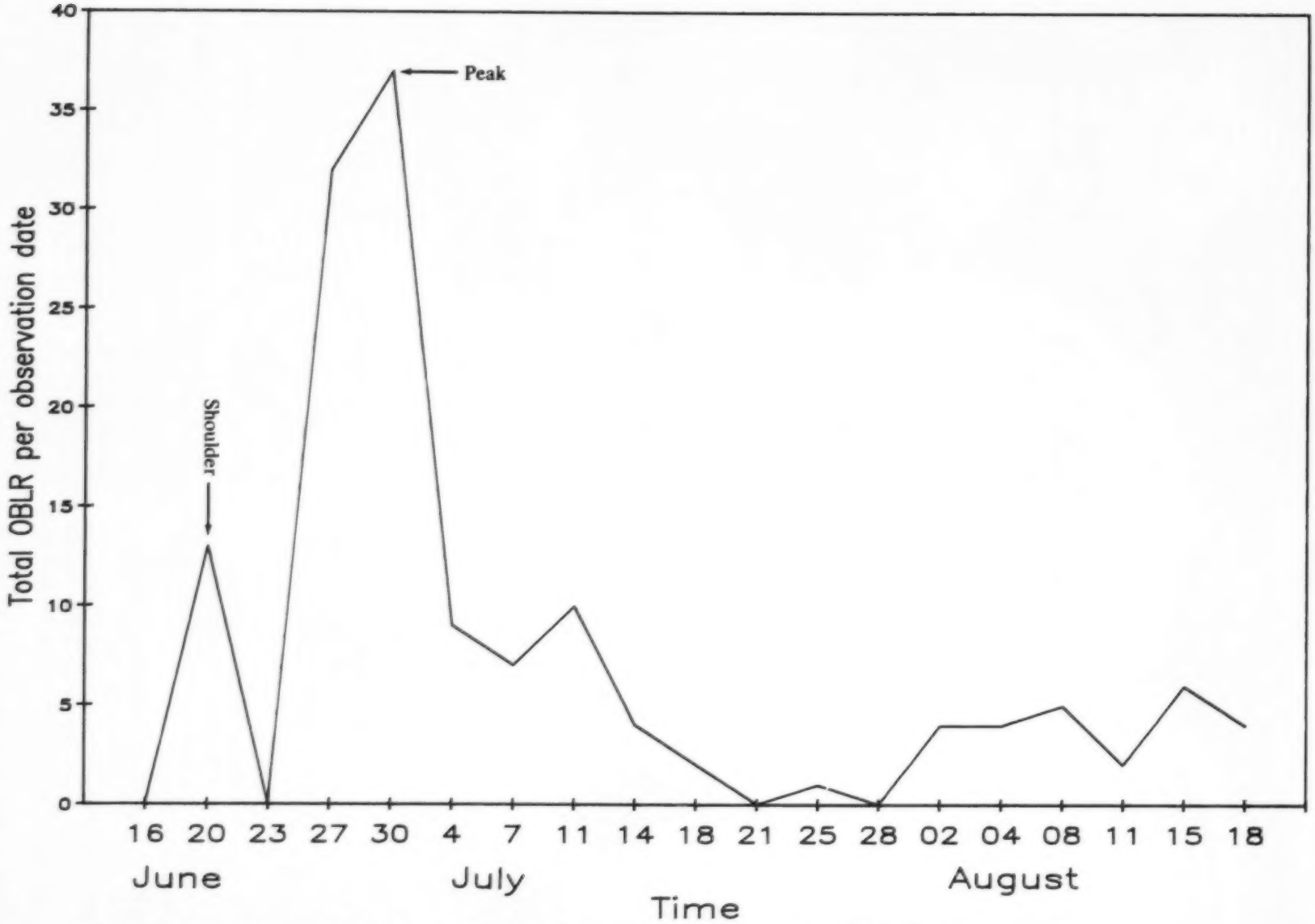


Figure 4. Catches of Oblique-Banded Leafroller Moths in Sex Pheromone Traps, Niagara Peninsula, 1983.
SEE REFERENCE 15.

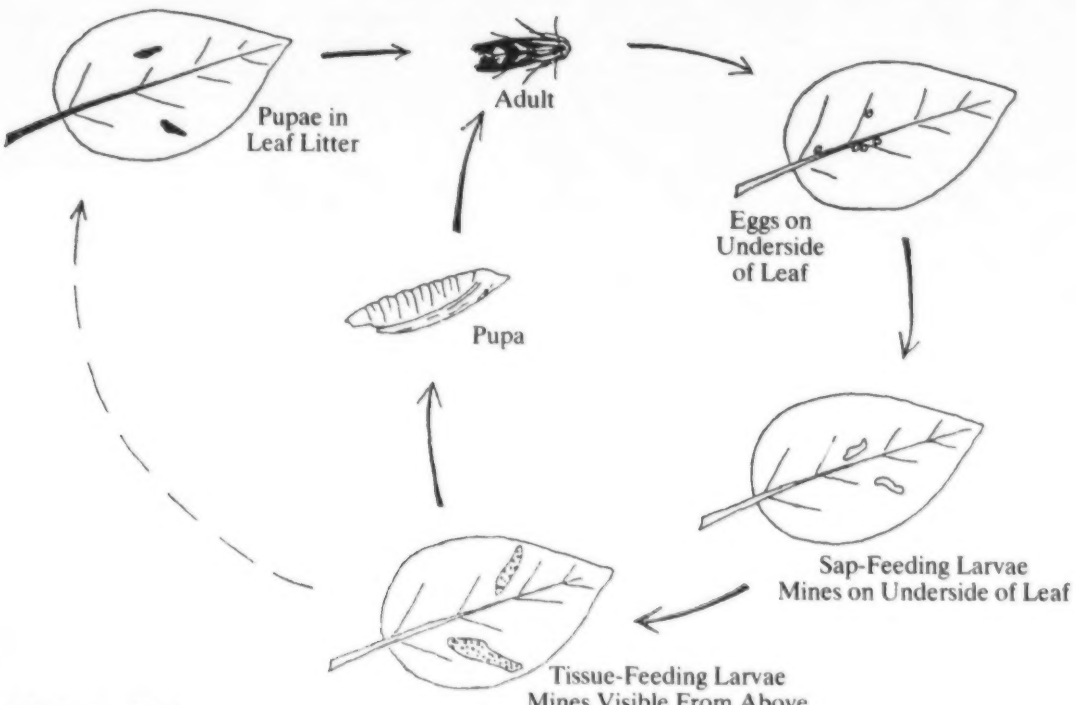


Figure 5. Life Cycle of TLM

at least 25 fruit spurs (5 spurs per tree from at least 5 well-spaced trees) in a single block. Samples should be collected from Red Delicious, McIntosh, Idared, or the predominant variety in a block. Repeated (weekly or twice weekly) sampling is necessary from half-inch green to petal fall, as egg counts can greatly increase in a short period of time.

Check all the unfurled leaves on a spur. For accurate egg counts, a microscope (40X) is necessary.

Thresholds and Control

If samples indicate an **average of 3 or more eggs per spur**, then a pyrethroid insecticide is recommended. If counts remain less than 3 eggs per spur, wait to control the next generation if necessary.

Do not rely on egg counts gathered in the field with a hand lens to determine if this threshold has been reached. Use a microscope, visit a Pest Management Clinic, and listen to the agriphone for your area.

Timing

TLM moth flight and egg laying can last 4-5 weeks. In order to control as many TLM as possible, delay the application of pyrethroids until first egg hatch (i.e., when the first sap-feeder is detected).

****DO NOT APPLY INSECTICIDES DURING BLOOM.****

Pyrethroids are toxic to bees. Do not apply pyrethroids within 48 hours of king bloom. Do not apply pyrethroids when bees are in the orchard (see Preventing Bee Poisoning, page 14).

If the threshold is reached and egg hatch is anticipated during bloom, apply pyrethroids 48 hours before bloom or at petal fall. If pyrethroids are to be applied when petals have fallen, bees must be removed as soon as pollination is complete. Pyrethroids do not control TLM larvae. If significant egg hatch occurs before pyrethroids can be applied, refer to control recommendations at calyx (see Emergency Treatment below).

Where TLM has been a serious problem in previous years, pyrethroids applied before bloom usually provide the best control.

Local agriphone reports will update growers on the development of TLM and local recommendations for control. Proper spray timing is very important for good TLM control.

General Note Use high volumes of water when spraying and do not spray in breezy conditions. Thorough spray coverage is necessary to control TLM eggs on lower leaf surfaces. It is important to get good coverage of the lower portion of the tree as well as the top and inside.

Notes on Materials In some areas of the province, TLM has developed low levels of resistance to pyrethroids. To delay further resistance development, **never apply pyrethroids more than once a year**.

Pyrethroids will also control spring-feeding caterpillars and tarnished plant bugs.

(2) EMERGENCY TREATMENT (after egg hatch)

If a pyrethroid was not applied before bloom or at petal fall (see page 48), continue sampling for TLM. If populations reach one or more sap-feeding mines per leaf, an emergency treatment may be required.

Monitoring

After TLM eggs begin to hatch, the sampling procedure changes from collecting entire fruit spurs to collecting spur leaves. Collect at least 5 leaves from each of 10 well-spaced trees in a block (at least 50 leaves, preferably 100). **Leaves should be collected from leaf and fruit clusters.** Examine the leaf underside for eggs and small trails or patches which are formed by sap-feeding larvae beneath the leaf surface. Very small mines (formed by 1st instar larvae) can only be seen by using a microscope.

Thresholds and Control

Apply Lannate if there is one or more mines per leaf and no pyrethroid has been previously applied. **This is to be used as an emergency treatment only, because Lannate interferes with IPM programs in orchards (see warning).**

Timing

Delay application of Lannate until the first tissue-feeder appears, so that the majority of TLM are in the sap-feeding stage. Lannate does not control tissue-feeding larvae.

Notes on Lannate Lannate is a locally systemic insecticide. Thorough coverage of all leaves is necessary to control larvae. Lannate should be applied in as much water as possible (at least 1000 L of water per hectare). Lannate will also control mullein bug, white apple leafhopper nymphs, oblique-banded leafroller larvae, other small caterpillars, and aphids. The residual activity of Lannate is short. It is effective for about 3-5 days.

WARNING TLM resistance has occurred in orchards where this material has been used repeatedly. **Lannate application at this timing (calyx) should be considered an emergency treatment rather than a routine application. Make no more than one application of Lannate a year.**

Lannate is very toxic to humans. Wear appropriate safety equipment. Do not re-enter the orchard for 24 hours after application.

Do not apply Lannate to Wealthy, Early McIntosh or Summer Glo cultivars or leaf injury will result.

Lannate is very toxic to beneficial insects and mites. Therefore, a single application may result in European red and two-spotted mite outbreaks. Repeated applications of Lannate may lead to increased populations of woolly apple aphids.

(3) SUMMER SPRAYS — SECOND GENERATION TLM

Lannate is recommended for control of second generation TLM only where the threshold is reached and Lannate was not applied for first generation control.

Monitoring

Collect at least 5, preferably 10, leaves from each of 10 well-spaced trees in a block. Leaves should be collected from halfway along the current season's shoot growth (see Figure 6). Examine the undersurface of the leaf for eggs and small trails or patches which are formed by sap-feeding larvae beneath the leaf surface. Very small mines (formed by 1st instar larvae) can only be seen by using a microscope.

Figure 6. Leaves to Sample for TLM — Second Generation. Sample the leaves indicated by shading

Threshold and Control

Apply Lannate if there are 4 or more mines per leaf on healthy trees, or 2 or more mines per leaf on stressed trees. Stress may be caused by mites, drought, a heavy crop, poor vigour, winter injury, etc.

Timing

Apply when the first tissue feeder of the second generation appears, when most larvae are in the sap-feeding stage. Check every 2-3 days for this event. Lannate does not control tissue-feeding larvae.

Notes on Lannate Lannate is a locally systemic insecticide. Thorough coverage of all leaves is necessary to control larvae. Lannate should be applied in as much water as possible (at least 1000 L of water per hectare).

Lannate will provide control of codling moth and oblique-banded leafroller for approximately 5 days. Dilute applications will also control or suppress woolly apple aphid.

WARNING Do not apply Lannate or any other pesticide when temperatures exceed 27°C. Lannate has been associated with leaf burning and leaf scorch, especially in hot,

humid weather and other slow drying conditions. Warnings listed under Emergency Treatment (page 50) also apply to Lannate application at this time.

Third Generation

Insecticides are neither recommended nor effective for control of third generation TLM. All stages of leafminer are present at this time, only some of which are controlled by an application of insecticide.

Tentiform Leafminer Parasites

There are several species of parasitic wasps which attack tentiform leafminer larvae. Parasitism of leafminer by these wasps is variable from orchard to orchard and is affected by the insecticides which have been applied.

The most important parasite, *Pholetesor ornigis*, is a tiny black wasp which parasitizes sap-feeding larvae. Many growers recognize the small white oblong cocoon of this parasite, which is found inside parasitized leafminer mines (see OMAF Factsheet, *Spotted Tentiform Leafminer*, Agdex 211/624).

The life cycle of TLM and *Pholetesor ornigis* are synchronized so that adult parasites are present when many leafminers are in the sap-feeding stage. The application of insecticides while adult parasites are active can significantly reduce their numbers. Azinphos-methyl (Guthion or APM) has long-lasting toxic residues.

The first generation of adult *Pholetesor* are active in orchards for 10-14 days after bloom. The use of azinphos-methyl and other organophosphorus insecticides at this time is devastating to parasite populations.

Therefore, azinphos-methyl to control spring-feeding caterpillars and plant bugs should be applied before bloom rather than at petal fall. To further increase parasitism, the calyx spray of azinphos-methyl should be delayed until plum curculio are active, and this spray should be limited to the outer 4-6 orchard rows if other pests are not present.

Other leafminer parasites, known as chalcids, are also important. These parasites attack tissue-feeding leafminer larvae. The effect of pesticides used in orchards on chalcid parasites is not known.

Reference 17. WHITE APPLE LEAFHOPPER (*Typhlocyba pomaria*)

General Notes

White apple leafhopper (WALH) is an occasional pest of apple trees in Ontario. Injury by WALH is primarily leaf stippling or mottling which may reduce tree vigour. Fruit spotting from WALH excrement may result in down grading at harvest, but this spotting may wash off if apples are packed on a packing line. Large WALH populations can be an irritant to pickers.

Life History

There are 2 generations of WALH each year: the first generation is active in May and June; the second generation is active in August.

Young WALH nymphs are creamy white in colour, about 1-1.5 mm long with dull red eyes. Older nymphs are yellow and develop wing pads. Adult leafhoppers have distinct wings, are creamy to pale yellow in colour, and fly or jump very rapidly when disturbed. Both nymphs and adults reside primarily on the lower leaf surface. For more information, see OMAF Factsheet, *White Apple Leafhopper*, Agdex 211/634.

Monitoring

First generation WALH can be found on fruit spurs near the scaffold limbs and tree trunk. Sampling for the first generation should be done weekly beginning at bloom until 7-10 days past calyx.

A sample for WALH should consist of 10 leaves from each of 10 trees (standard), or 5 leaves from each of 20 trees (dwarf) for a total of 100 leaves. Collect leaves at arm's length into the trees. **Examine each leaf, especially on the lower surface close to the mid-vein, as it is picked** because WALH move quickly when disturbed.

Monitoring for second generation is the same as for first generation.

Leaf stippling is a good indicator of WALH activity.

Threshold

A suggested threshold for treatment is 2-5 nymphs per leaf in the 100 leaf sample.

Control and Timing

First Generation Pirimor is the recommended insecticide for control at this time.

Pirimor is most effective against young nymphal stages. It is not as effective when adult WALH are present, or after wing pads have developed on most nymphs.

Second Generation There are no IPM preferred materials recommended for WALH control at this time of the growing season. Other materials are available, but these may cause additional pest problems. If specific problems arise, contact your local Pest Management Advisor or Horticultural Crops Advisor for assistance, and watch closely for problems early the following year.

WARNING Some countries impose a zero tolerance for Pirimor residues on fruit shipped from Canada. Check with your packer before applying this material.

Reference 18. WOOLLY APPLE APHID (*Eriosoma lanigerum*)

The woolly apple aphid (WAA) is primarily a pest of elm and apple. WAA is distinguished from other aphids by a covering of white waxy material that makes its colonies resemble small tufts of wool or cotton batting. The actual insect lies below this covering and is reddish-purple in colour. For further information, see OMAF Factsheet, *Woolly Apple Aphid*, Agdex 211/634.

Damage by WAA in the previous season can be identified by the formation of knots or galls on twigs or roots where the colony was established. Fruit injury may be observed as sooty mould on the surface of the apple. The mould develops on the sticky "honeydew" secreted by WAA feeding on tissue above the fruit.

Monitoring

Woolly apple aphid nymphs overwinter in various protected parts of apple trees, particularly at the base of root suckers and beneath loose or dead bark around wounds and pruning cuts. The progress of woolly apple aphid nymphs or crawlers should be monitored closely as they move from overwintering sites. WAA is attracted to soft, succulent tissue such as rapidly growing suckers or water

sprouts. Eventually, they may move to bearing twigs and branches. Colonies develop most rapidly at the base rather than the tips of shoots and are often found at the base of the leaf attachment to the shoot. Infestation by WAA should be detected in early June to minimize damage to the host tree and fruit. Low populations early in the season may build to epidemic proportions by July and August. Therefore, monitoring should continue through June, July and August.

Threshold

Growers need not worry about chemical control unless colonies of WAA are noticed in close proximity to fruit clusters.

Control

Cultural practices have a significant impact in reducing WAA population levels in the orchard. Good practices include:

1. removing suckers at the base of the tree to eliminate a favoured WAA site;
2. removing suckers and water sprouts from scaffold limbs to eliminate WAA feeding sites and to allow for better spray penetration and coverage;
3. pruning in the summer (late July — early August) to remove colonies from the tree.

If many WAA colonies are close to fruit clusters, spray with Pirimor using high volumes of water (at least 1400 L/ha). Complete and thorough coverage is essential.

WARNING Pirimor has a 35-day interval to harvest. Some countries impose a zero tolerance for Pirimor residues on fruit shipped from Canada. Check with your packer before applying this material.

Occasional Pest References

DISEASES

Reference 19. PHYTOPHTHORA COLLAR ROT (*Phytophthora cactorum*)

Collar rot problems have been experienced in situations where apple trees are planted in heavy soil, poorly drained soil, or were replanted in old orchard sites. This disease, caused by a long-lived, soil-borne fungus, is especially damaging to apple trees grown on MM 106 rootstock. Trees on M 26 and MM 111 rootstocks are intermediate in susceptibility, while M 7A and M 9 rootstocks are moderately resistant. Do not plant susceptible rootstocks where concern for collar rot is present.

For problem areas, metalaxyl (Ridomil) is registered for use on **NON-BEARING** trees only. Apply Ridomil 240 EC as a drench to the soil around the base of the tree; use 4.25 ml in 5 L of water per tree. Make the first application at planting and repeat in late August. In subsequent non-bearing years, apply Ridomil in the early spring and again in late August. This treatment will suppress fungal growth and development. However, the fungus will survive in the soil. Long-term control should include resistant rootstocks and proper site selection.

Before planting, completely fumigate old orchard sites. Strip fumigation is acceptable for soil where apples have not been grown. Do not plant susceptible rootstocks (especially MM 106) on wet sites, **even if tiled**, because only one wet spring can cause problems. Use Ridomil **only** if the problem occurs where **tolerant** or mildly resistant rootstocks are planted following very severe soil waterlogging. Do not rely on Ridomil for control instead of using good management practices such as choosing a good site and using the proper rootstock.

Reference 20. SOOTY BLOTCH (*Gloeodes pomigena*) and **FLY SPECK** (*Microthyriella rubi*)

Orchards with a full-season scab-control program usually do not need additional fungicide applications to control sooty blotch and fly speck. These diseases are best controlled with fungicides which have good residual properties.

If fungicide sprays are stopped too early in the season (40-60 days before harvest), sooty blotch and fly speck can cause problems when there are frequent showers, high humidity, and moderate temperatures (15-20°C is optimal).

High levels of inoculum may be present in dead twigs or in brushy hedgerows. Therefore, inadequately pruned trees, which are located in areas with poor air drainage, are prone to these diseases.

Sooty blotch and fly speck are difficult to control in areas which dry slowly because of fog or dew. Trees should be well pruned to facilitate drying. In scab-free orchards where fungicides are not being used, apply 1-2 sprays at 10- to 14-day intervals starting in early August if prolonged wet weather occurs. The last fungicide should be applied 30 days before harvest.

Control

1. Captan 50% WP 6.00 kg/ha
   or
   Captan 80% WP 3.75 kg/ha
2. Phaltan 50% WP 6 kg/ha
3. Zineb 80% WP 4.25 kg/ha

Reference 21. TREE CANKERS

Apple tree cankers are caused by any one of a number of fungi, including *Nectria, Cytospora, Botryosphaeria, Schizophyllum, Trametes*, and *Polyporous*. Each require a very similar approach to control. These fungi usually infect only the weakened or stressed trees in an orchard. Trees damaged by cold temperatures are particularly susceptible to these pathogens. Evidence of fungal infection is often first noticed 3 to 4 years after the winter injury has occurred. Severely infected trees, which are not economically productive, should be removed. In addition, stresses or wounding agents that can predispose apple trees to canker must be corrected to prevent further problems. Many deciduous trees, often found in woodlots or fence rows around the orchard, are hosts of these diseases. Therefore, dead or dying trees around the orchard should be removed as well.

Canker control is best approached by good orchard management practices such as:

1. Proper Site Location: Before planting, choose a good site. Avoid locations where water stress is likely to occur. Plan the orchard so cold air will drain away from the trees, reducing the chance of winter injury.
2. Good Fertility Program: Provide apple trees with adequate, but not excessive nutrition, as determined by soil tests and regular leaf analysis.
3. Good Pruning Practices: Beginning early, shape the tree properly so that large branches do not have to

be removed later. Broken and damaged branches should be pruned out promptly so that they can heal before canker diseases invade. The development of strong, healthy branches with good angles (e.g., 45°) between the limb and the trunk will help reduce the invasion of decay-causing fungi.

4. Sanitation: Diseased material should be removed from the orchard and burned. Do not mulch prunings in blocks where cankers are a problem.
5. Bordeaux mixture, applied during the dormant period, may help suppress the incidence of canker.

Reference 22. BLISTER SPOT (*Pseudomonas syringae* p.v. *papulans*)

Blister spot is a bacterial disease which causes brown blister-like spots mainly on the fruit of the apple cultivar Mutsu (= Crispin). However, other cultivars, such as Golden Delicious, Red Delicious, and Cortland, can also become infected if planted close to Mutsu having this disease.

The bacteria overwinter in dormant buds and on fruit left on the orchard floor. In spring, the bacteria multiply and are spread by rain to apple foliage and neighbouring trees and weeds. Fruit are susceptible to infection for only a short time — from about 2 weeks after petal fall until late July. More information can be found in the OMAF Factsheet, *Blister Spot of Apples*, Agdex 211/634.

Control

No chemicals are registered for control of blister spot. However, growers should be aware of the biology of this disease in order to take precautions which could reduce its spread.

1. Obtain budwood from a source known to be free of blister spot.
2. Buy apple trees from a nursery which uses clean budwood.
3. Avoid overhead irrigation when fruit are susceptible to infection, beginning 10-14 days after petal fall.
4. Do not leave apples on the ground over the winter, and do not discard blister spot-infected fruit in or around the orchard.
5. Do not plant new Mutsu plantings near older ones. Isolation from other varieties (e.g., Red Delicious, Golden Delicious and Cortland) is also advised, because these can become infected if they are located near Mutsu having high infection levels.

INSECTS

Reference 23. APPLE SEED CHALCID (*Torymus druparum*)

The apple seed chalcid is an occasional pest of apples that is usually controlled by insecticides applied for other insect pests. No specific spray is required for the apple seed chalcid.

The larvae of this insect overwinter in seeds of apples and crab apples and pupate in late May, with adults appearing in mid-June. Adults damage the fruit by stinging the surface of the apple and depositing eggs in the seeds. At harvest, the injury appears as a depression in the apple. If the apple is cut in half from stem to calyx, a brown streak will be present from the skin to the seed. This differs from the damage caused by TPB, which appears as a brown streak that often extends to the calyx. TPB injury does not affect the seeds.

Reference 24. EYE-SPOTTED BUD MOTH (*Spilonota ocellana*)

Eye-spotted bud moths (ESBM) overwinter as partially grown larvae within a silken case attached to the base of spurs or twigs of the host tree. Larvae are dark brown in colour with black heads. They become active in the spring when apple trees reach the half-inch green stage. Bud moth larvae feed on opening buds and form shelters by tying several leaves together. The larvae may also burrow into newly developing shoots. Because of this feeding activity and the shoot damage it causes, early season bud moth injury can be devastating to a young orchard.

The larvae are fully mature in 5-7 weeks and then pupate within rolled leaves. Adult moths, which are similar in appearance but smaller than codling moths, are dark grey with a large white band across the middle of the wings. Moths begin to emerge in mid-June, with adult flight continuing into July.

Eggs are laid singly on the apple leaves. The peak egg laying activity occurs in mid-July. Eggs hatch in approximately 10 days, and the young larvae feed on the leaf undersides. A shelter of leaves and frass is constructed. Damage to the apple will occur if the larvae feed under leaves which touch the fruit. This feeding injury is characterized by tiny, circular, shallow excavations of the fruit surface, similar in appearance to late-season plum curculio feeding injury. These holes are most often seen at harvest, since they are located under leaves tied to the fruit.

Insecticides applied for tentiform leafminer or spring-feeding caterpillars, codling moth, and apple maggot usually give adequate control of eye-spotted bud moth. Insecticides applied in late August for apple maggot are important for the control of late-season injury.

Reference 25. DOGWOOD BORER (*Synanthedon pyri*) and APPLE BARK BORER (*Synanthedon scitula*)

These two borers are mainly a problem on dwarf and semi-dwarf trees, where they bore into burr knots. Since the borers feed under the bark near the graft union, this injury may predispose the tree to winter injury or infection from disease.

Borers overwinter as larvae under the bark. In spring, the larvae pupate and adults emerge in mid- to late-June. The adults are clear-winged moths and are active until mid-August. Eggs are laid in the soft bark tissue on or near burr knots.

Several control methods are available:

1. Plant trees so that the bud union is 1 to 2 centimetres above the soil line. This will prevent the development of burr knots, which are just as harmful to tree growth as borer injury.
2. Use wire mesh tree guards instead of plastic, as the plastic provides a protected environment for the borer to live in.
3. The following recommendation only applies to orchards with high levels of infestation:

   When moths are present (late June to early August), apply Ambush plus Superior oil (Ambush 500 EC 170 mL/1000 L + Superior oil 20 L/1000 L) to the tree trunk until runoff using a handgun applicator. Make 2 applications at a 2- to 3-week interval. Ambush is toxic to beneficial mites and insects. Cultural controls are preferred.

Reference 26. MISCELLANEOUS CATERPILLARS

There are many different caterpillars which are sometimes found in orchards. These are easily controlled by broad-spectrum insecticides applied for other pests such as tentiform leafminer, codling moth, and apple maggot. Caterpillars may become a problem in orchards on a reduced spray program, and are most often found in non-bearing orchards where insecticides are not applied for direct fruit pests.

Many caterpillars feed on a variety of deciduous plants, including wild fruit trees, hardwoods, wild raspberries, etc. Infestations of caterpillars are most likely to occur in orchards adjacent to bush, woods, or hedgerows.

Leafrollers, such as the red-banded leafroller, are very common in unsprayed orchards and are potentially very destructive in commercial sites (see Reference 15, Spring-Feeding Caterpillars). Some leafrollers have 2 generations a year. Larvae of the second generation are active in August and September, when they feed on the surface of maturing fruit. Feeding damage is shallow and irregular, and often sheltered by leaves tied to the fruit or by several fruits in a cluster.

Small leafrollers can suspend themselves on silken threads which carry them throughout the orchard with the breeze. Although infestations are more serious and noticeable at the orchard periphery, small larvae will easily spread some distance into the orchard.

Larvae of the **eye-spotted bud moth** are easily distinguished from other caterpillars by their black head and brown body (see Reference 24, page 54).

Gypsy moth, Eastern tent caterpillars and fall webworms are sometimes found in orchards located near deciduous woods. Each can cause extensive defoliation on localized branches or limbs. Gypsy moth and tent caterpillars are active in spring, while fall webworms are found in late July and August.

Monitoring

Checking for unexpected infestations should be included in the orchard monitoring routine. Leafroller feeding on shoot growth sometimes creates a "rat-tail" appearance. Late-season fruit damage from leafrollers and bud moth is difficult to detect before harvest. Check clustered fruit in August for signs of feeding injury, frass, and webbing.

Thresholds and Control

There are no thresholds for the control of miscellaneous caterpillars, as they usually occur sporadically. Infestations in a well-sprayed orchard may indicate a problem with spray coverage. Where insecticides for tentiform leafminer, codling moth, or apple maggot are not applied, watch for damage. Phosmet (Imidan) will control most leaf- and fruit-feeding caterpillars. Caterpillars are more easily controlled if they are small rather than full grown. Where infestations of fall webworm or Eastern tent caterpillar occur, prune out and destroy colonies if possible; this is more effective than spraying.

Table 12. Number of Days From Last Spray to Harvest

Read the Label and Follow All Safety Precautions.

Canada's Department of National Health and Welfare has established the amounts of insecticides, miticides, and fungicides that may remain on fruits at time of harvest. To avoid exceeding these tolerances, use recommended amounts and do not spray nearer to harvest than the number of days shown below, nor later than the stage indicated. This is subject to change by Information Letter as additional information is available. For tank mixes of two or more materials, use the longest time period given for any of the materials.

DO NOT APPLY A PESTICIDE MORE OFTEN THAN RECOMMENDED ON THE LABEL.

Pesticide	Days to Harvest
Ambush	7
APM	7
Belmark	60
Benlate	1
Benlate & Captan	7
Benlate & Manzate/Dithane	30
Benlate & Polyram	7
Captan	7
Carzol	1
Cygon 480 E	14
Cymbush	7
Cyprex	7
Decis	1
Diazinon	14
Dikar	30
Dithane DG	30
Easout + Captan	7
Equal	7
Ferbam	7
Guthion	7
Imidan	1
Karathane	21
Kelthane	7
Lannate	8
Manzate 200	30
Morestan	Pre-bloom application only
Omite	7
Phaltan	1
Phygon XL	1
Pirimor	35
Polyram	7
Pounce	7
Ripcord	7
Streptomycin 17	50

Table 13. Chemical Families of Pesticides

Type of Pesticide	Chemical Family	Common or Chemical Name	Examples of Brand or Trade Name
Bactericides	Antibiotic	streptomycin sulfate	Streptomycin 17
Fungicides	Benzimidazole	benomyl	Benlate
		thiophanate-methyl	Easout
	Dithiocarbamate	ferbam	Ferbam
		mancozeb	Dithane DG Manzate 200
		metiram	Polyram
	Dithiocarbamate and Dinitrophenol	mancozeb and dinocap	Dikar
	Dinitrophenol	dinocap	Karathane
	Guanidine	dodine	Cyprex, Equal
	Phthalimide	captan	Captan
		folpet	Phaltan
	Quinone	dichlone	Phygon XL
Insecticides	Carbamate	methomyl	Lannate L
		pirimicarb	Pirimor
	Organophosphorus	diazinon	Diazinon
		dimethoate	Cygon
		phosmet	Imidan
		azinphos-methyl	Guthion, APM
	Petroleum Oil	oil	Superior Oil
	Pyrethroid	cypermethrin	Cymbush, Ripcord
		fenvalerate	Belmark
		permethrin	Ambush, Pounce
		deltamethrin	Decis
Miticides	Carbamate	formetanate hydrochloride	Carzol
	Carbonate	chinomethionat	Morestan
	Chlorinated Hydrocarbon	dicofol	Kelthane
	Petroleum Oil	oil	Superior Oil
	Sulphite	propargite	Omite

Table 14. Physical Compatibility of Spray Materials

Where a blank appears on the chart, the materials can be used together.

☐ —Compatible

X —Do not use together

• —Not recommended together in this calendar

? —Compatibility unknown

Do not mix pesticides in Streptomycin, thinning sprays or foliar fertilizers.

The chart applies only to the use of two material spray combinations for deciduous fruit. **When three or more materials are tank-mixed together, further incompatibility may develop.**

Compatibilities of some materials may depend upon solvents and emulsifiers used by the manufacturer. Emulsifiable concentrate formulations are more likely to cause compatibility problems than wettable powders. **If wettable powders are mixed with emulsifiable concentrates, incompatibilities may result.**

Do not allow spray mixtures to sit overnight.

1. Should not be used with or within 14 days of oil application.
2. May cause injury under some weather conditions.
3. Consult manufacturer regarding suitable oil for combination to be used on apple. Do not use it later than half-inch green stage.
4. Use EC formulations.
5. Use WP formulations.
6. Apply immediately with agitation.
7. When mixing captan with EC formulations of pyrethroids, add captan first. Apply immediately with constant agitation.
8. Chemically similar materials.

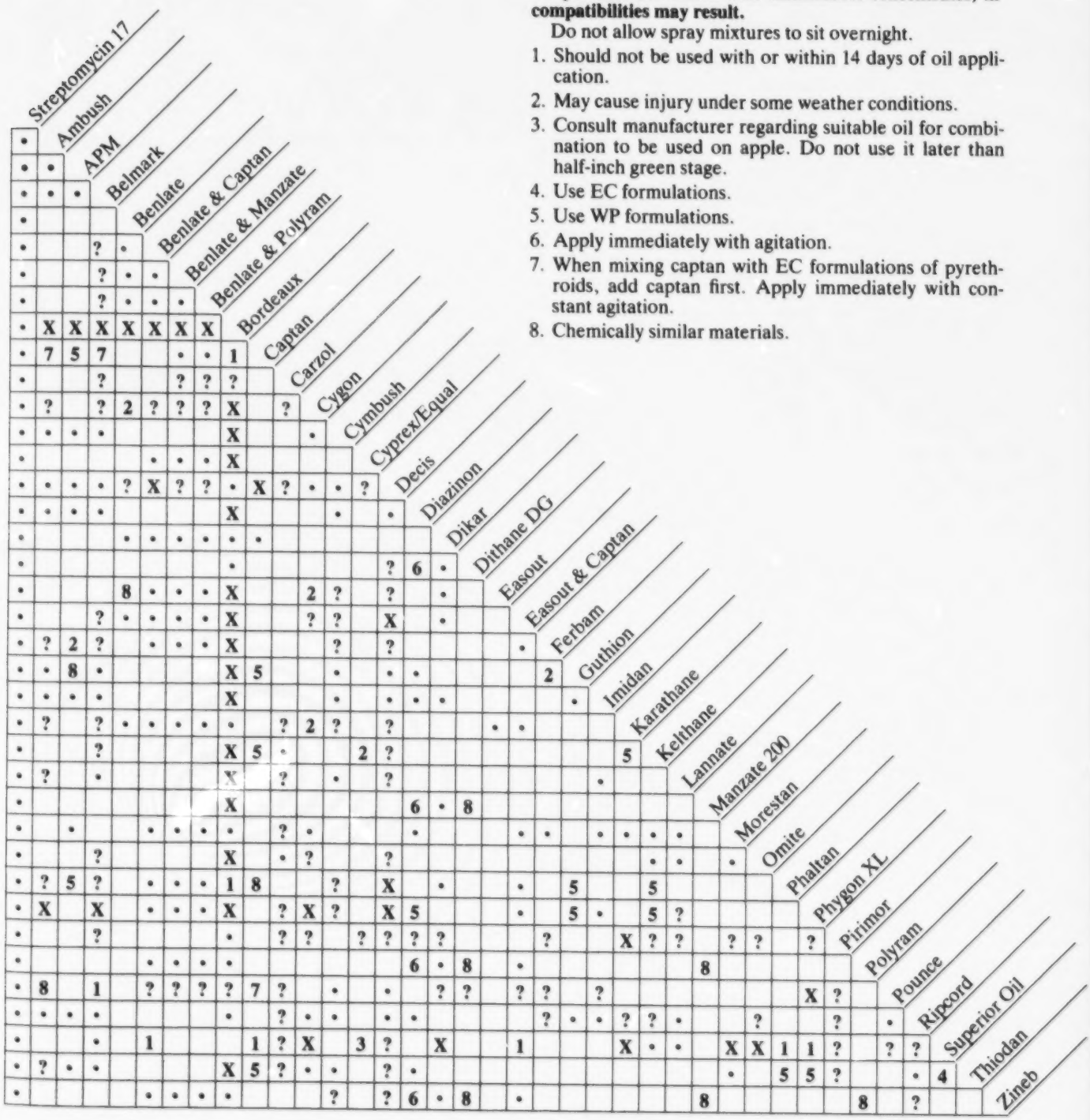


Table 15. Selected List of Monitoring Equipment Suppliers

Product	Supplier
Pheromone Traps and Wicks	Plant Products Co. Ltd. 314 Orenda Rd. BRAMALEA, Ontario L6T 1G1 (416) 793-7000
	Trece Incorporated P.O. Box 5267 SALINAS, CA 93915, U.S.A. (408) 758-0204
Temperature Recorders (also see Plant Products)	Enercorp Instruments Ltd. P.O. Box 20, Station "U" TORONTO, Ontario M8Z 5M4 (416) 231-5335
	Reuter Stokes Canada Ltd. 465 Dobbie Dr. CAMBRIDGE, Ontario N1R 5X9 (519) 623-4880
Leaf Wetness Recorders	D.R. Woudstra c/o Valley Stream Farms ORONO, Ontario (416) 983-5915
Tangle Trap	Tanglefoot Company 314 Straight Ave. S.W. GRAND RAPIDS, MI 49504, U.S.A. (616) 459-4130
Maggot Balls	Great Lakes IPM 10220 Church Rd. VESTABURG, MI 48891, U.S.A. (517) 268-5693
Hand Lens (also see Plant Products)	Wards Natural Science Ltd. P.O. Box 1278, Station "B" MISSISSAUGA, Ontario L4Y 3W5 (416) 279-4486
Mite Brushing Machine	Llanfair Orchards R.R. #1 OKANAGAN FALLS, B.C. V0H 1R0 (604) 764-2332 or Llanfair Technology 903-210 Somerset St. West OTTAWA, Ontario, K2P 0J4 (613) 234-8461

PUBLICATIONS

The following Factsheets relating to insect and disease pests of apples should be obtained as they supplement the information presented in this publication:

	Factsheet	Order No.
211/634	Apple Maggot	88-093
211/634	Cedar-Apple Rust and Quince Rust	83-020
211/634	Fire Blight of Apple and Pear	78-058
211/634	Pin-Point Scab of Apples	76-012
211/634	Powdery Mildew of Apple	88-124
211/634	Blister Spot of Apples	89-100
211/634	Apple Scab	86-028
211/634	Woolly Apple Aphid	86-035
211/634	Codling Moth	86-037
211/634	White Apple Leafhopper	87-004
211/634	Green Apple Aphid	87-005
211/624	Spotted Tentiform Leafminer	88-067

ORCHARD: _____ **19___ ORCHARD SPRAY RECORD**

COUNTY: _____

Application Date	Variety and/or Block	Chemical Product Name	Concentration & Formulation	Number of Acres/Hectares Sprayed or Treated	Number of Tanks Applied	Size of Tanks Imp. Gallons U.S. Gallons Litres	Amount of Chemical per Tank
Examples: May 5	all	Polyram	80 W	45	9	400 imp. gal.	13.5 kg
June 10	N.E. Macs	Polyram	80 W	12	3	1500 Litres	11 kg

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